THE

MAGAZINE OF SCIENCE,

AND

SCHOOL OF ARTS:

INTENDED TO ILLUSTRATE THE MOST USEFUL, NOVEL, AND INTERESTING PARTS

OF

NATURAL HISTORY AND EXPERIMENTAL PHILOSOPHY,

ARTISTICAL PROCESSES,

ORNAMENTAL MANUFACTURES, AND THE ARTS OF LIFE.

EDITED BY

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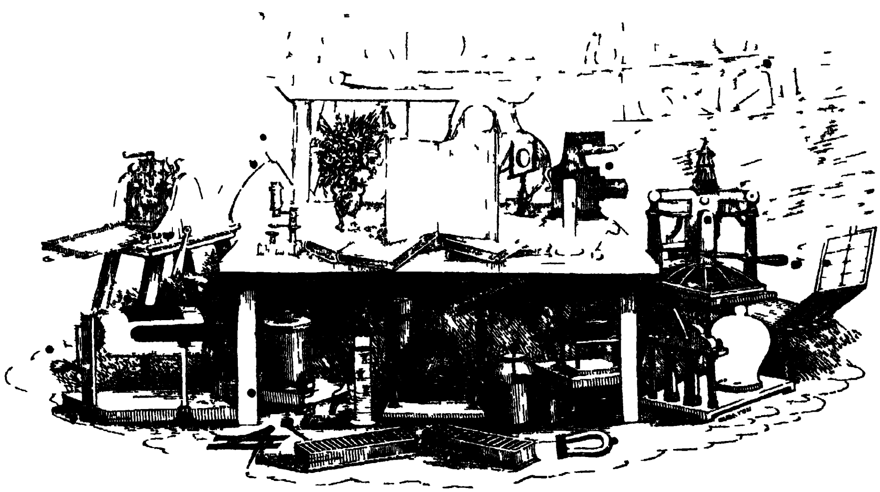

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PREFACE

TO THE FIRST EDITION.

The termination of a second volume calls from us a few remarks, relative both to the past and the future. The time during which it has been in the course of publication (from April 1840 to April 1841) has been one rich in scientific discoveries. Were there no others than those relative to the different departments of Electricity, it would stamp a renown upon the year that is past. But there are very numerous others, recorded in the following pages, worthy of the utmost attention, and which must eventually lead to results of the utmost value to mankind.

All those discoveries we have taken especial care to record, at as early a period as it has been possible to obtain a full and correct account of them; and if we have appeared to neglect some subjects which other periodicals have included in their current reports, it is because they are not so valuable as at first sight they may appear, or because the accounts known or given are too obscure to be intelligible; or it is possible that, with the most careful search, we may by chance have overlooked them. A few subjects have been delayed only that we might introduce them with better effect in continued articles. Of this description are the numerous Electro-Magnetic Engines, which will meet with our immediate attention.

With the advantage even of a prolific scientific year, yet the whole learned world does not make sufficient discoveries to fill even a little work like this; therefore we have had recourse to other matter, and explained such processes of art, and such phenomena of nature, as are useful to be known, perfecting each part with that miscellaneous and scientific information, which we have considered to be least known. Hence have arisen those extensive papers on Varnishing, the Analysis of Minerals, Botany, Galvanism and Electricity, Lithography, and numerous others.

The Queries which we have answered have been less than in the last volume, but the Correspondents we have attended to have been incalculably more numerous; and if we have not at all times attended to the wishes of our Friends, but tried their patience by a delay in reply, it has arisen from causes over which we had no control.

PREFACE.

In the third volume we shall go on in the same steady manner, and give our Friends the earliest and the best information which we can procure, on all matters relevant to the subject of science, particularly of the experimental parts of it; and instead of flagging in our course, we trust to be enabled to impart to our work an increasing interest, by subjects not yet touched upon, as well as by the continuation of others which we have hitherto been enabled only to commence.

Our Friends will be glad to hear that the remark we made in the first volume is now still more applicable; that this work, which they have fostered with so much kindness, continues to increase its sale—which, gratifying as it was a twelvemonth since, is now still more encouraging. To all our kind Friends, Contributors, and Readers, we return our most sincere thanks.

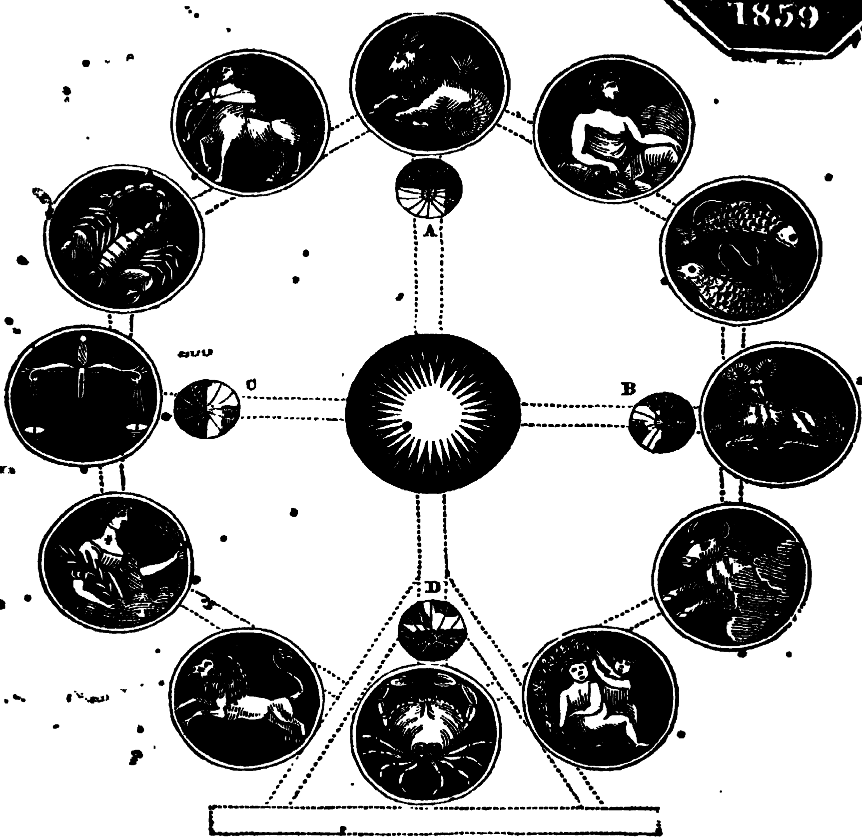
THE EDITOR.

PREFACE TO THE SECOND EDITION.

Notwithstanding the sale of the many thousands of copies which formed the first Edition, the continued and steady demand still made for it has induced the proprietors, at a great expense, to reprint, and, in many cases, to remodel parts of the present volume by the introduction of newly-written articles and much important miscellaneous matter, and also to increase the number and accuracy of the engravings—thus endeavouring to render the work still more worthy of public patronage.

March, 1844.

The Magazine of Science and School of Arts



ASTRONOMICAL ILLUSTRATIONS.

ASTRONOMICAL ILLUSTRATIONS.

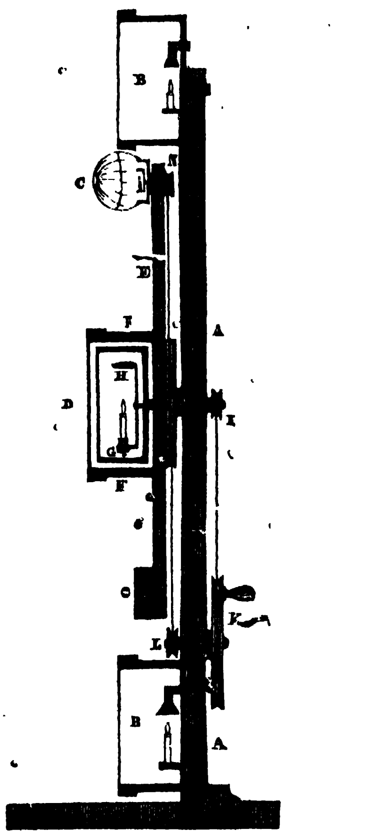
The science of astronomy requires for its illustration apparatus of a totally different character from that of any other science—no minute articles are here required, nothing depends upon either delicate manipulation, or quality of ingredients, no possibility of error can occur; all is dark around—no noise of machinery is heard, all is on a quiet scale, and works as silently as possible; all that is not to be seen is black and disregarded, that our attention may not be distracted, but fixed and rivetted upon the one sole object before our eyes. The lecturer himself is invisible, that our minds may be referred to the mighty system of creation, whose illustration we are witnessing. Another mark of distiuction between astronomy and other sciences is that they appeal to our senses, to our reason and imagination—thus it becomes necessary in lecturing on this science to aim at immensity, and splendor of apparatus, that the mind may as far as is possible be made to grasp some at least of the infinitely more stupendous apparatus of the universe.

An account of the vertical tellurian as it is called, or that machine which represents the motion of the earth, will we are sure be interesting, and it is hoped useful, more especially as there is we believe no work whatever which contains a plain description of any of these machines.

Fig. 1 represents the machine when complete; it is seen to consist of the twelve signs of the zodiac, arranged in a circle, signifying the twelve months of the year. In the centre of these is the sun, and at four equi-distant points a representation of the earth, as it appears when entering into each of the four seasons; when at B, opposite Aries, it will enter the spring quarter, and the terminator will be seen passing through the pole — when opposite Cancer D, it will be the summer solstice, the north pole of the earth as shown will be in darkness, the north pole consequently objected to the sun's light, making our summer. Three months afterwards it passes to Libra, or the autumnal equinox, and when another quarter of the circle is complete, it will have passed to Capricorn or mid-winter. When in action the whole will be in darkness except the twelve signs of the zodiac, the earth and the sun. The construction of the machine is as follows:—The dotted part of the first figure shows a frame work of strong timber, the whole being as large as the room in which it is to be exhibited will allow to be used with convenience: for theatrical exhibition 30 or 40 feet is not unusual; for private use it must be at least 18 or 20 feet.

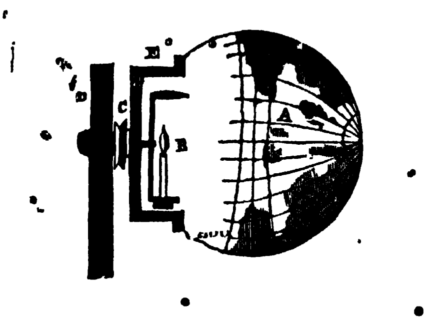
The signs should be at least 3 feet diameter, and placed close, or nearly close together in the circle; the sun 2 feet, and the earth 18 inches—if either be less than this the effect will be greatly diminished, for nothing is more likely to produce dissatisfaction, and it may be said contempt, than diminutive astronomical apparatus, and if circumstances will not allow of extensive machinery, it is far better to trust to the illustration afforded by a magic lanthorn, than machinery so small as not to raise a feeling of awe and grandeur.

The next cut shows the same machine viewed sideways. The foot and strong upright support A A show the dotted part seen in the former figure, with the exception of the frame work, which supports the signs of the zodiac. B B are two opposite signs, either of which shows the structure of the whole. They are made like drums, a round piece of wood forms the back several holes being cut in the lower part of it, to admit air to feed the candle flame. The sides may be of brown paper, with three or four wooden ribs, to sustain the brown paper of its proper shape, and also to hold a light hoop, which finishes it towards the front. The picture is a common transparency, fastened on a hoop, which will fit upon the front of the paper drum. It is lighted by a solitary wax candle, which is furnished with a tin chimney passing through the back to carry off the smoke. C is the earth, afterwards to be described. D is the sun, formed of two drums, the outer one is formed exactly like those of the signs, except as to candle and chimney: it is fastened to the part E; this is represented at F F. Within is another drum G, having within it a candlestick, supported by its centre, holding a candle below, and a flat piece of tin over the candle to prevent its burning the top. The candlestick is made moveable, in order that the candle should be perpendicular, notwithstanding the rapid revolution of the other part. The front of the sun is made of varnished silk; for greater brilliancy the two drums have rays painted on them in contrary directions, as represented when treating of Chinese fireworks in the former volume.



The requisite motions are, that the sun should have a dazzling scintillating appearance given to it, and that the earth should turn on its axis, at the

same time that it revolves in its orbit around the sun; also that at two parts of its course its axis should be parallel to the sun, at the intermediate points it should be inclined at the proper angle 23½°. All this is done by an extremely simple arrangement of wheel-work; we have represented it by wheels and cords, as working without noise; it may be moved, however, by cogged wheels, with the same effect. Mr. Wallis's machinery is a mixture of both, chiefly the latter. K is a wheel worked by a handle; it passes through the upright support A, and has upon the other side of A a small pulley L. The wheel K turns a small pulley I, which passing through to the drum G, keeps it in rapid motion, the candle within it standing still. The pulley L turns a large wheel at the back of the bas-ot wood E. This large wheel being fastened to E turns that round also, and consequently moves the earth in its orbit, and equally keeps in motion the second transparency of the sun. The earth is turned on its axis by means of a second groove there is on the wheel at the back of E, carrying a cord over a pulley at N. O is merely a counterpoise weight for the earth at the opposite end of the beam. The relative rapidity of the various methods of course depends upon the relative proportion of the various wheels. The structure of this imitative earth is better seen in the accompanying figure.



A, the part seen in front, is formed of a wire frame work, (the wires forming the lines across it,) covered with sections of muslin, painted so as to represent a north polar projection of the earth. E is a drum, made as in the former instances. B is the candle, suspended as in the sun before mentioned. C the pulley which turns on its axis. D the upright bar of support. If it be requisite that the axis should be oblique to its orbit of revolution, and which is necessary properly to show the seasons, the same contrivance and adjustment is necessary, as was indicated in the description of the horizontal tellurian in the former volume.

The machine now described is equally applicable to show the action of the tides, the lunar motions, eclipses, and the general arrangement of the solar system. These applications we purpose to recur to hereafter.

CITRIC ACID.

This acid exists in many vegetables, either free, or combined with lime; it is especially abundant in lemon-juice, from which it was first obtained in a crystalline form by Scheele: it is contained in gooseberries, raspberries, and other fruits, and is often associated with malic acid.

Citric acid is obtained from lemon or lime-juice as follows:—Boil the expressed juice for a few minutes, and, when cold, strain it through fine linen: then add powdered chalk as long as it produces effervescence; heat the mixture, and strain as before: a quantity of citrate of lime remains upon the strainer, which, having been washed with cold water, is to be put into a mixture of sulphuric acid with 20 parts of water: the proportion of acid may be about equal to that of the chalk employed. In the course of 24 hours, the citrate of lime will have suffered decomposition, and sulphate of lime is formed, which is separated by filtration. The filtered liquor, by careful evaporation, furnishes crystallized citric acid. The preparation of this acid is carried on by a few manufacturers upon an extensive scale; in different states of purity, it is employed by the calico-printers, and used for domestic consumption. Many circumstances which have not here been alluded to are requisite to ensure complete success in the operation: these have been fully described by Mr. Parkes, in the third volume of his *Chemical Essays*. The average proportion of citric acid afforded by a gallon of good lemon-juice is about eight ounces. Dr. Henry states that he has obtained as much as twelve ounces.

Citric acid forms beautiful crystals, of which the primary form is a right rhombic prism. They have a very sour taste, and are soluble in somewhat less than their own weight of water at 60°, and in half their weight at 212°. They also dissolve in alcohol. M. Tilloy, of Dijon, recommends gooseberries as a source of citric acid; they are bruised, and the expressed juice is fermented, and then distilled to obtain the alcohol; the residue is saturated by chalk, and the washed citrate of lime decomposed by sulphuric acid: from 100 parts of gooseberries he obtained 10 of alcohol and 1 of acid. Citric acid is sometimes fradulently mixed with the tartaric: the adulteration may be discovered by gradually adding to the acid dissolved in water, a solution of carbonate of potassa, which will occasion the precipitation of bitartrate of potassa, if tartaric acid be present.

The crystals of citric acid include a certain proportion of water, part of which may be expelled by heat in its *anhydrous* state, as it exists combined with certain bases. The crystals of citric acid, deposited from its saturated solution at 212°, contain 1 atom of water. These crystals fuse at a little above 212°, into a limpid liquid, without loss of weight, and concrete on cooling into a solid transparent mass. The crystals which are obtained by the spontaneous evaporation, at common temperatures, of a solution of citric acid, differ in composition from the former, and contain 3 atoms of anhydrous acid and 4 of water. These crystals are permanent at common temperatures, but when dried at 212° they effloresce and lose exactly half their weight of water. When any attempt is made to drive off more water by the application of higher temperature the acid is itself decomposed.

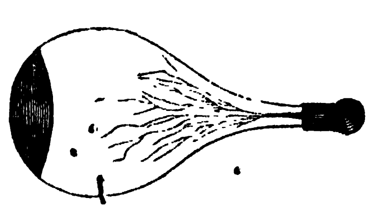
ATMOSPHERIC ELECTRICITY,

(*Resumed from page 334, Vol. I., and concluded.*)

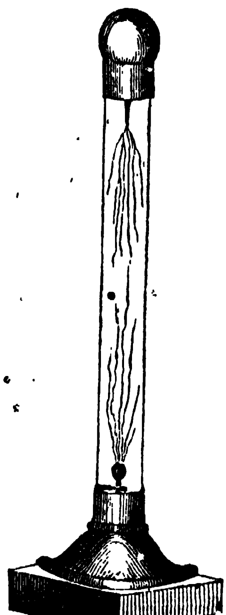
Aurora Borealis.—After the identity of lightning and the electric fluid was established, the explanation of the Aurora Borealis was easy. Mr. Dalton gives a spirited description of one, which

appeared on the 13th of October, 1792. He says, "There first appeared a dull red light, sufficiently strong to read by; all on a sudden the whole hemisphere was covered with streams of light, and exhibited such an appearance as surpasses all description. The intensity of the light, the prodigious number and volatibility of the beams, the grand intermixture of all the prismatic colors in their utmost splendor, variegating the glowing canopy with the most luxuriant and enchanting scenery, afforded an awful, but at the same time the most pleasing and sublime spectacle in nature. The point to which all these beams and flashes tended, was in the magnetic meridian, and as near as could be determined 15° or 20° south of the zenith. The Aurora continued, though diminishing in splendor, for several hours." When the northern lights appear in this country, they occur chiefly in the spring or autumn, and usually after a period of dry weather. They are seen more rarely in countries near the equator, but are visible almost constantly during the long winters in the polar regions, and with a lustre of which we can form but a faint conception.

In the Shetland Islands they are called "*merry dancers*," and are the regular attendants of clear weather, giving a diversity and cheerfulness to the long winter nights. In Hudson's Bay the refulgence of Aurora is stated to be frequently equal to that of the full moon. In the northern latitudes of Norway and Sweden, their brilliancy is so remarkable and constant, as to enliven the path of the traveller during the whole night. In the N.E. part of Siberia, they are also described as moving with incredible velocity, and clothing the sky with a most brilliantly luminous appearance, resembling a vast expanded tent, covered with gold, sapphires, and rubies. The reasons why this phenomenon has been attributed to electricity, are, 1st. That whenever it appears, the atmosphere is found replete with the electric fluid. 2nd. It equally. with electricity, influences the magnetic needle. It puts on appearances different from lightning because it occurs at a considerable altitude above the earth, where of course the air is much rarefied. If this be the case, it will be proper in order to imitate it, that we should pass the electric matter through a very rare medium; and this is done with a flask similar to the following.—It may be made of a common oil flask, though infinitely more imposing if of four times the size; its thicker end has a portion of it covered with tin-foil, sufficient, that when held by the hand, the glass itself may not be touched. The neck is fitted with a brass cap and ball, with a pointed wire projecting inside; this ball should take off, and show underneath it a screw, with a valve opening outwards, that the flask may be partly exhausted of air. No tin-foil is necessary inside, which may be also quite dry.



Ex.—To imititate the Aurora Borealis, make the flask dry and warm, partly exhaust it of air then screw on the ball,—hold it by the tin-foil of the thick end, and present the other to a charged conductor, flashes of a beautiful reddish purple light will pervade the glass flask exactly similar to the phenomenon wished to be imitated. The following is a long tube of glass, fixed to a foot, and furnished with a cap and ball, and pointed wire at top, with the valve at the foot. It is first to be fixed to an air pump or exhausting syringe, and the air partially drawn out; when a spark being passed through it, by touching the upper ball by a wire communicating with the prime conductor of the machine, it passes down the tube to the foot, and, according to the density and quality of this medium, so will be the color of the flashes, while their frequency and brilliancy will depend upon the quantity transmitted.



Falling Stars.—Whenever the electric fluid is at a moderate height, and in a more concentrated form, it occasions those electrical appearances, known to us as falling stars or meteors; these are generally considered indicative of rain, and not without some cause, inasmuch as rain, hail, snow, &c. are always produced by any sudden electrical change that takes place. They may be imitated by passing a shock through a long exhausted tube, similarly constructed to that described and figured above; but not exceeding half an inch in diameter.

Rain, Snow, &c.—It has been said by some, that the reason rain, &c. falls in drops, and still more so, why snow appears in light fleecy flakes is owing to electrical repulsion, as is somewhat proved by the experiment of the expansion of a fleecy feather when driven off by an excited tube, and also by the spun sealing-wax.

Earthquakes.—Earthquakes also have probably an electric origin, they have been considered as immense shocks passing through the earth; the circumstances in favor of this theory are the rapidity of their passage, the convulsive motion which they

occasion, and that they are always attended by lightning and other electrical appearances.

Fiery Rain.—Thus also can we in some degree explain the fiery rain mentioned in the Scriptures, and by various ancient writers; certain it is that every drop of rain which falls during a thunder-storm is charged with the fluid, and therefore contributes to divest the storm of its fury.

Water-spout.—The water-spout, that wonderful and terrific object, is too easily explained by electric attraction to leave any doubt that its cause is a highly-charged state of the air, and we are confirmed in this conclusion by the means taken to disperse it, which is by firing cannon and pointing sharp weapons at it.

Whirlwind.—What the water-spout is at sea, the whirlwind is on land, a current of the electric fluid passing along and carrying with it the light bodies it passes over. If the currents or columns of electric matter fall upon a surface of the earth, covered by non-conducting substances, such as the scorched sands of Africa, the sands are elevated, moving along with the wind, and constituting what are called the *moving pillars of sand of the desert.* In those burning climes, the air is so dry, and at the same time insulated from the earth, by the parched sand, that large tracts of electric matter move almost in a pure uncombined state, appearing like a blush in the heavens, and producing all the effects of a deprivation of air, by suffocating every animal exposed to their influence. The camel, the dromedary, and the ostrich, instinctively bury the nose in the sand, and the travellers in the ill-fated caravan fall flat upon their faces to avoid being immersed in the electric fluid. In this state it occasions such combinations and decompositions that its effects are felt even across the Mediterranean as far as the shores of Italy, forming the Sirocco of Volney, and the Simoon of Bruce.

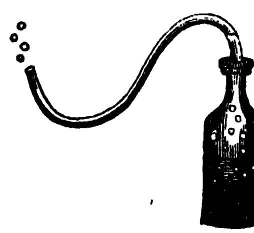
The foregoing is a synopsis, rather than an explanation of the natural effects of electrical agency—nor is it, in the very limited manner in which it has been described, to be considered wholly proved, that earthquakes and falling meteors are attributable to this active power,—on the contrary, the whole subject needs reflection, and close comparison of circumstances and effects—and which perhaps a future opportunity will be allowed us to consider and to explain.

CHEMICAL ELEMENTS.

HYDROGEN.

HYDROGEN was first obtained pure by Mr. Cavendish in 1766. It is a colorless gas, permanently elastic, without taste, and when perfectly pure, without smell. It is the lightest body known, being sixteen times lighter than oxygen, or thirteen times lighter than atmospheric air, its specific gravity being 0·0694, and 100 cubic inches of it weighing 2·118 grains. It cannot support combustion or respiration; but is itself in an eminent degree inflammable, requiring, however, oxygen to support the combustion; it may be set fire to by any material made red hot, it explodes when mixed with oxygen or the atmospheric air, forming water, and its heat when burning is greater than that of any other material.

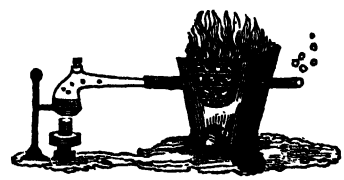
Ex. 1.—*To procure hydrogen from iron, sulphuric acid, and water.*—Put into a wine bottle, a few iron nails, add some water, and then sulphuric acid, equal in quantity to one fourth of the water; the iron nails will in a minute or two be covered with bubbles of gas, which will rise to the top of the vessel. Hold a candle near the gas as it passes away from the mouth of the bottle, and by its taking fire it will be known to be oxygen. It may be collected either with a bent tube passing under the shelf of the pneumatic trough, or by a bladder fastened to the mouth of the bottle.



In this experiment the water is decomposed, its oxygen unites with the metal as it is acted upon by the acid, and the other constituent of the water, viz, hydrogen, being light, escapes upwards. One ounce of iron yields 782 cubic inches of gas.

Ex. 2.—*To procure hydrogen from zinc, sulphuric acid, and water.*—Use some pieces of zinc, cut small, instead of the iron in the last experiment, and a tolerably pure hydrogen will be rapidly liberated—it may be collected as before. This gas is often called hydrozincic gas, it holding minute portions of zinc suspended in it. One ounce of zinc yields 676 inches of gas. It is produced more rapidly in this manner than in the former.

Ex. 3.—*To procure hydrogen from water.*—Pass an iron tube, or gun barrel, open at both ends, through a fire. Make it red hot, and to one end fasten a retort holding water—make this water hot, by a lighted lamp being placed under the retort, so that the steam may pass through the red hot iron tube. In this transit it will be decomposed, the oxygen being absorbed by the iron, rendering that an oxyde, while the hydrogen passes through, and may be collected at the other end of the tube, which ought to dip under the surface of water, that the gas may be cooled and purified.



Ex. 4.—A porcelain tube, filled with ignited charcoal, will no less decompose water, liberating the hydrogen; but in this experiment carbonic acid gas arising from the charcoal, also passes over and thus contaminates the gas, until by long contact with water, the carbonic acid is absorbed, and the hydrogen remains.

Ex. 5. *Destructive to animal life.*—Drop a small animal into a jar of hydrogen, and it will be instantly deprived of life. This appears to arise not from any deleterious property of the gas, but merely owing to the non-existence of oxygen, as mixtures of hydrogen and oxygen are respirable.

Ex. 6. *Effect on the voice when inhaled.*—Fasten a large mouth piece or wide tube to a bladder filled with hydrogen gas; put it to the mouth, and, stopping the nostrils, inhale only the hydrogen, and the voice will become shrill, and then be completely lost for a short time. This is supposed to arise on account of the extreme tenuity and lightness of the gas not having sufficient momentum to affect the organ of sound.

Ex. 7. *Gilding silk, ivory, &c. by hydrogen.*—Immerse a piece of white satin, silk, or ivory, in a strong solution of nitro-muriate of gold. While this substance is still wet, immerse it in a jar of hydrogen gas; it will after some time be covered by a complete coat of gold. The hydrogen in this experiment decomposes the oxyde of gold, which is the base of the salt, appropriating to itself the oxygen, and suffering the gold to be deposited in a metallic state.

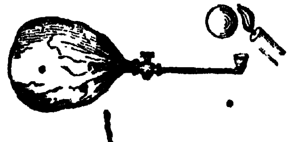
Ex. 8. *Producing gilt flowers, &c., on silk or ivory.*—The foregoing experiment may be varied as follows:—Paint flowers, &c., on the silk with the nitro-muriate of gold, and the aid of a very fine camel-hair pencil. Hold the silk thus painted over the bottle in which hydrogen is being liberated; in a short time the flowers will shine with considerable brilliancy, and will not tarnish upon exposure to the air. The thickness of the coating of gold is not more than the ten-millionth part of an inch.

Ex. 9. *Silvering by hydrogen.*—Immerse a white silk ribbon in a solution of nitrate of silver, and while wet expose it to a stream of hydrogen. The silver will be reduced to a metallic state on the silk. This may be varied, as in the preceding experiment. The same effect takes place with platinum, but not with any of the other metals, because all the others hold the oxygen contained in their oxydes too tenaciously for hydrogen to decompose them.

Ex. 10. *Inflammability of hydrogen.*—To the mouth of the bottle in which the gas is generating, (as in *Ex.* 1 and 2,) fit a cork which has a tobacco pipe stem passing through it. The gas will pass through the pipe, and may be inflamed at the top, forming what has been called the philosophical candle.

Ex. 11.—Hold over the bottle in which the gas is forming a long tube, stopped at the upper end, which will soon be filled with the gas; wrap a handkerchief round this bottle, merely to defend the hand, and without turning it up—that is still with its open end downwards. Set fire to the contents; a dull explosion takes place, and the hydrogen will be seen to burn away slowly, upwards, as each part when consumed permits the air to come in contact with the next.

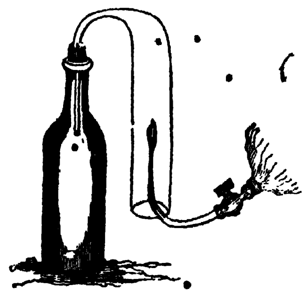
Ex. 12. *Hydrogen soap bubbles.*—Blow some soap bubbles, filling them from a bladder of hydrogen, furnished with a brass pipe. They will ascend rapidly to the ceiling; if they are interrupted in their course by a lighted candle they will explode with a dull report and a flash of yellow light.



Ex. 13. *Oxygen necessary for its inflammation.*—Let a shred of potassium fall into a bottle containing *only* hydrogen and a little water, and the gas will not take fire. This may easily be tried in the bottle in which hydrogen is being formed, (as in *Ex.* 1 and 2;) but if a portion of common air be present explosion ensues, therefore great caution is necessary in performing the experiment.

Ex. 14. *Not a supporter of combustion.*—Into a jar of hydrogen immerse suddenly a lighted taper, and although the gas itself will be inflamed the flame of the taper will be extinguished, and by no methods can it be thrust down into the gas, and remain alight—showing that though combustible hydrogen is not a supporter of combustion.

Ex. 15. *Oxygen appears to burn.*—Fasten to the top of a bottle, where hydrogen gas arises, a tube of glass, shaped like a syphon, one leg of which may be about an inch or an inch and a half in diameter. Place this tube so that this leg may hang down parallel to the bottle, so that the gas can only issue into the atmosphere at the lower end, where being lighted, it will, if the gas be abundant, continue to burn quietly without the flame ascending into the tube itself; while thus burning, thrust into the flame, and through it into the body of the gas above, a fine tube from which oxygen is issuing very slowly, the jet of oxygen will appear to burst into flame immediately it comes near, and to burn in the midst of the hydrogen.



This is a very singular experiment, and it would appear as if the oxygen were the combustible, and the hydrogen the supporter of the combustion; but the fact is, that hydrogen burns in the midst of hydrogen, without inflaming that around it, the combustion being supported only where it meets with the oxygen, thus it burns in a film of exactly the shape of the jets issuing into it. If the jet of oxygen be not extremely minute, an explosive mixture of the two gasses is very liable to be formed.

Ex. 16. *Effect of water on burning houses.*—Water thrown upon a house when on fire, if not in over-powering quantity, adds to the mischief, as the great heat decomposes it; its oxygen and hydrogen both aiding the combustion.

Ex. 17. *Light and heat of inflamed hydrogen.*—In the above experiments, where hydrogen burns, the flame is bluish or yellowish, and so faint as in daylight to be scarcely visible; it is however intensely hot. To test this, hold a fine rod of glass to the point of the flame, and it instantly becomes red hot, and may be blown or beat to any shape; a candle, piece of paper, &c. instantly takes light if held to the fine jet issuing from the light bottle in the last experiment.

(*Continued on page* 29.)

VARNISHING.

There is no art which adds so much to the increase of beauty of manufactured articles as varnishing, if we remember that every liquid which communicates a permanent gloss to the article it is washed over with is a varnish, and that therefore lacquering, waxing, French polishing, the laying on of glazes, and many other processes, are but modifications of the art of varnishing, its extent and general application will be apparent.

Varnishes are made by dissolving certain of the gums and resins in oil, turpentine or alcohol, and according to which of the menstrua is employed, so the varnish is called oil varnish, turpentine varnish, and spirit varnish. The former kind has the strongest body—the last dry the quickest.

The following are the modes of preparation of some of the most useful kinds, with the purposes to which they are generally applied.

To make Varnishes for Violins, &c.—To a gallon of rectified spirit of wine, add six ounces of gum sandarac, three ounces of gum mastich, and half a pint of turpentine varnish. Put the whole into a tin can, which keep in a warm place, frequently shaking it, for twelve days, until it is dissolved; then strain, and keep it for use.

To make Caoutchouc Varnish.

16 oz. of caoutchouc, or elastic resin.
16 oz. boiled linseed oil, and
16 oz. of essence of turpentine.

Cut the caoutchouc into thin slips, and put them into a mattrass placed in a very hot sand-bath. When the matter is liquefied, add the linseed oil in a state of ebullition, and then the essence warm. When the varnish has lost a great part of its heat, strain it through a piece of linen, and preserve it in a wide-mouthed bottle. This varnish dries very slowly, a fault which is owing to the peculiar nature of the caoutchouc.

The invention of air balloons led to the idea of applying caoutchouc to the composition of varnish. It was necessary to have a varnish which should unite great pliability and consistence. No varnish seemed capable of corresponding to these views, except that of caoutchouc, but the desiccation of it is exceedingly tedious.

To make Pliable Varnish for Umbrellas.—Take any quantity of caoutchouc, as ten or twelve ounces, cut it into small bits with a pair of scissors, and put a strong iron ladle, (such as that in which painters, plumbers, or glaziers, melt their lead,) over a common pit-coal or other fire, which must be gentle, glowing, and without smoke. When the ladle is hot, put a single bit into it: if black smoke issues it will presently flame and disappear, or it will evaporate without flame; the ladle is then too hot. When the ladle is less hot, put in a second bit, which will produce a white smoke; this white smoke will continue during the operation, and evaporate the caoutchouc; therefore no time is to be lost, but little bits are to be put in, a few at a time, till the whole are melted—it should be continually and gently stirred with an iron or brass spoon. The instant the smoke changes from white to black, take off the ladle, or the whole will break out into a violent flame, or be spoiled or lost. Care must be taken that no water be added, a few drops only of which would, on account of its expansibility, make it boil over furiously, and with great noise; at this period of the process two pounds or one quart of the best drying oil is to be put into the melted caoutchouc, and stirred till hot, and the whole poured into a glazed vessel through a coarse gauze, or wire sieve. When settled and clear, which will be in a few minutes, it is fit for use, either hot or cold.

The silk should be always stretched horizontally by pins or tenter-hooks on frames, (the greater they are in length the better,) and the varnish poured on *cold in hot weather*, and *hot in cold weather*. It is perhaps best always to lay it on when cold. The art of laying it on properly consists in making no intestine motion in the varnish, which would create minute bubbles, therefore brushes of every kind are improper, as each bubble breaks in drying, and forms a small hole, through which the air will transpire.

Varnish for Watch-Cases, in imitation of Tortoise-shell.

6 oz. of copal of an amber color,
1½ oz. Venice turpentine,
24 oz. prepared linseed oil, and
6 oz. essence of turpentine.

It is customary to place the turpentine over the copal, reduced to small fragments, in the bottom of an earthen or metal vessel, or in a mattrass exposed to such a heat as to liquefy the copal; but it is more advantageous to liquefy the latter alone, to add the oil in a state of ebullition, then the turpentine liquefied, and, in the last place, the essence. If the varnish is too thick some essence may be added. The latter liquor is a regulator for the consistence in the hands of an artist.

To make a Colorless Copal Varnish.—As all copal is not fit for this purpose, in order to ascertain such pieces as are good, each must be taken separately, and a single drop of pure essential oil of rosemary, not altered by keeping, must be let fall on it. Those pieces which soften at the part that imbibes the oil are good; reduce them to powder, which sift through a very fine hair-sieve, and put it into a glass, on the bottom of which it must not lie more than a finger's breadth thick. Pour upon it essence of rosemary to a similar height; stir the whole for a few minutes, when the copal will dissolve into a viscous fluid. Let it stand for two hours, and then pour gently on it two or three drops of very pure alcohol, which distribute over the oily mass, by inclining the bottle in different directions with a very gentle motion. Repeat this operation by little and little, till the incorporation is effected, and the varnish reduced to a proper degree of fluidity. It must then be left to stand a few days, and, when very clear, be decanted off. This varnish, thus made without heat, may be applied with equal success to pasteboard, wood, and metals, and takes a better polish than any other. It may be used on paintings, the beauty of which it greatly heightens.

Gold-colored Copal Varnish.

1 oz. copal in powder,
2 oz. essential oil of lavender, and
6 oz. essence of turpentine.

Put the essential oil of lavender into a mattrass of a proper size, placed on a sand-bath heated by an Argand's lamp, or over a moderate coal fire. Add to the oil, while very warm, and at several times, the copal powder, and stir the mixture with a stick of white wood, rounded at the end. When the copal has entirely disappeared, add at three different times the essence, almost in a state of ebullition, and keep continually stirring the mixture. When the solution is completed, the result will be a varnish of a gold color, very durable and brilliant.

Camphorated Copal Varnish.—This varnish is destined for articles which require durability, pliableness, and transparency, such as the varnished wire gauze, used in ships instead of glass.

2 oz. of pulverized copal,
6 oz. of essential oil of lavender,
½ of an oz. of camphor, and
essence of turpentine, a sufficient quantity, according to the consistence required to be given to the varnish.

Put into a phial of thin glass, or into a small mattrass, the essential oil of lavender and the camphor, and place the mixture in a moderately-open fire, to bring the oil and the camphor to a slight state of ebullition; then add the copal powder in small portions, which must be renewed as they disappear in the liquid. Favor the solution by continually stirring it with a stick of white wood, and when the copal is incorporated with the oil add the essence of turpentine boiling; but care must be taken to pour in, at first, only a small portion.

This varnish is little colored, and by rest it acquires a transparency, which, united to the solidity observed in almost every kind of copal varnishes, renders it fit to be applied with great success in many cases, and particularly in the ingenious invention of substituting varnished metallic gauze in the room of Muscovy talc, a kind of mica, in large laminæ, used for the cabin windows of ships, as presenting more resistance to the concussion of the air during the firing of the guns. Varnished metallic gauze of this kind is manufactured at Rouen.

Ethereal Copal Varnish.

½ oz. of amberry copal, and
2 oz. of ether.

Reduce the copal to a very fine powder, and introduce it by small portions into the flask which contains the ether; close the flask with a glass or cork stopper, and having shaken the mixture for half an hour, leave it at rest till the next morning. In shaking the flask, if the sides become covered with small undulations, and if the liquor be not exceedingly clear, the solution is not complete. In this case, add a little ether, and leave the mixture at rest. The varnish is of a light lemon color. The largest quantity of copal united to ether may be a fourth, and the least a fifth. The use of copal varnish, made with ether, seems, by the expense attending it, to be confined to repairing those accidents which frequently happen to the enamel of toys, as it will supply the place of glass to the colored varnishes employed for mending fractures, or to restoring the smooth surface of paintings which have been cracked and shattered.

(*Continued on page* 31.)

MISCELLANIES.

Consumption of Smoke.—Mr. Rodda has patented a means of consuming smoke, by means of parting off a portion of the back of a furnace with fire-brick, so that when the coal has been coked in the forepart, it is thrust into the hinder division; and the smoke from the freely-supplied coal being made to pass over the incandescent coked fuel, is consumed. The principal merit of this invention is its simplicity; consisting merely of a few fire-bricks; which may be placed in any furnace without expensive alteration.

Large Sheet of Paper.—There has been lately sent from the manufactory at Colinton, a single sheet of paper, weighing 533 pounds, and measuring upwards of a mile and a half in length; the breadth being only 50 inches. Were a ream of paper composed of similar sheets made, it would weigh 266,5000 pounds, or upwards of 123 tons.

Mikrotypopurogenelion.—Take a page, or any other definite portion of printed paper, cut it into two pieces, note the *size* of the type, and place one piece aside as the muster or test. Thrust the other piece between the bars of a lighted grate, or ignite it in any other manner which may be preferred; place it gently on the hearth, and let it burn away, till entirely consumed. Take up the paper so charred carefully, and, holding it to a good light, the size of the print, which is perfectly legible, will be found to have become considerably reduced, while the sharpness, or purity of impression, will have been singularly increased.

Triumphs of Chemical Science. — Of all the achievements of inorganic chemistry, the artificial formation of *lapis lazuli* was the most brilliant and most conclusive. This mineral, as represented to us by nature, is calculated powerfully to arrest our attention by its beautiful azure-blue color, its remaining unchanged by exposure to air or to fire, and furnishing us with a most valuable pigment (ultra-marine), more precious than gold! Analysis represented it to be composed of silicia, alumina, and soda (three colorless bodies), with sulphur and a trace of iron. Nothing could be discovered in it of the nature of a pigment, nothing to which its blue color could be referred, the cause of which was searched for in vain. It might, therefore, have been supposed that the analyst was here altogether at fault, and that, at any rate, its artificial production must be impossible. Nevertheless, this has been accomplished; and simply by combining, in the proper porportions, as determined by analysis, silicia, soda, alumina, iron, and sulphur. Thousands of pounds weight are now manufactured from these ingredients, and this artificial ultra-marine is as beautiful as the natural, while for the price of a single ounce of the latter we may obtain many pounds of the former.—*Liebig.*

QUERIES FROM VOL I.

150—How are animal skeletons prepared and bleached?—*Answered on page* 157.

164—How are work-boxes, &c., japanned?—*Answered on page* 103.

167—How are turkey's-maw balloons prepared?—*Answered on page* 104.

168—How are Bath bricks made?—*Answered on page* 61.

175—What is there in the juice of the lemon, &c., which, used as a sympathetic ink, causes it to appear dark when scorched by fire?—*Answered on page* 414.

QUERIES.

185—What is harness polish, and its preparation?—*Answered on page* 63.

186—How is printing in gold performed? Also, the materials for colored printing inks?—*Answered on pages* 104 *and* 184.

187—How is the thunder, lightning, rain, hail, and wind of the theatres produced?

188—What is the best fly net for entomological purposes?

189—How are insects in cabinets best preserved?—*Answered on page* 415.

190—Does moonlight act in any way upon vegetation?

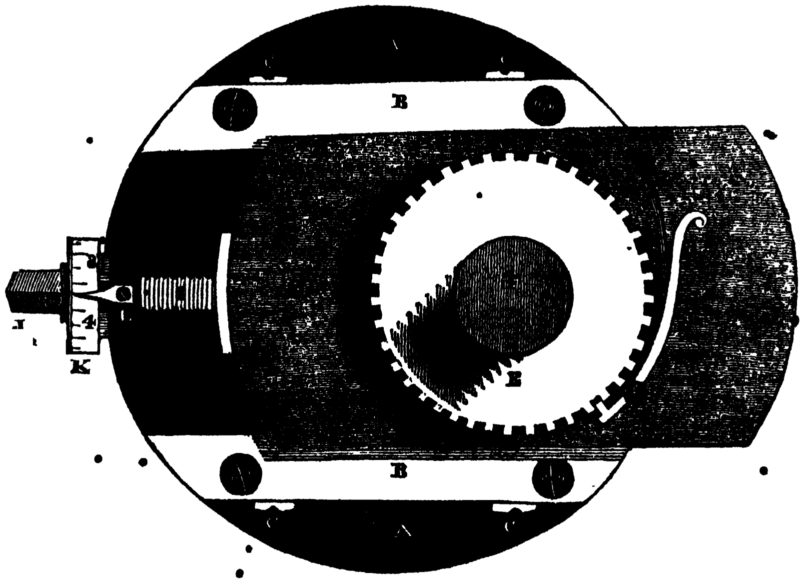
191—What is the process of cleaning furs?

192—What causes the different colors in the flame of a candle?—*Answered on page* 84.

193—How and of what material are Meershaum pipes made?—*Answered on page* 415.

194—How are the common cake water colors made?—*Answered on page* 214.

Fig. 1.



TURNING.—THE ECCENTRIC CHUCK.

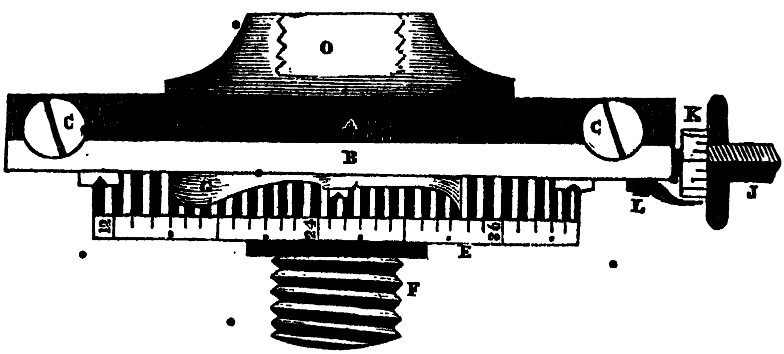
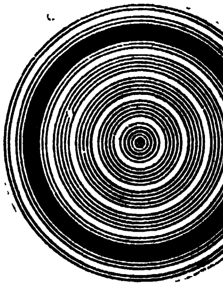


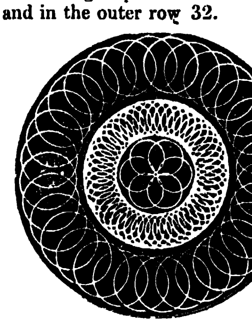
Fig 2.

THE ECCENTRIC CHUCK.

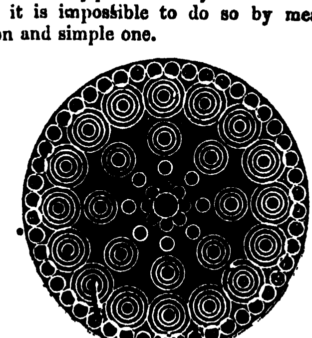
One of the most useful appendages to an amateur's lathe is the eccentric chuck. Its particular properties are to enable the turner to alter the centre of his work at pleasure, thus the work produced exhibits a beautiful intermixture of circular lines, or ornaments, and which cannot be produced by a common chuck. To illustrate this the two following cuts exhibit the properties of the common and the eccentric chuck.



In the above the various lines are all around the same centre, and consequently of different sizes throughout, (their size and distance from each other depends upon the position of the tool and not upon the chuck.) In the next illustration there are three groups of equal-sized circles, but each one in every group is from a different centre, not any one of them agreeing with the centre of the whole, though the groups are respectively equi-distant from it. In the innermost group are six circles, in the centre one 48, and in the outer row 32.



The next illustration shows groups of concentric circles, made around certain points, and also other circles either free from each other, or just touching. This also is easily performed by the eccentric chuck, though it is impossible to do so by means of a common and simple one.



The description of the chuck, which permits such alteration of adjustment as to occasion this eccentricity, is as follows:

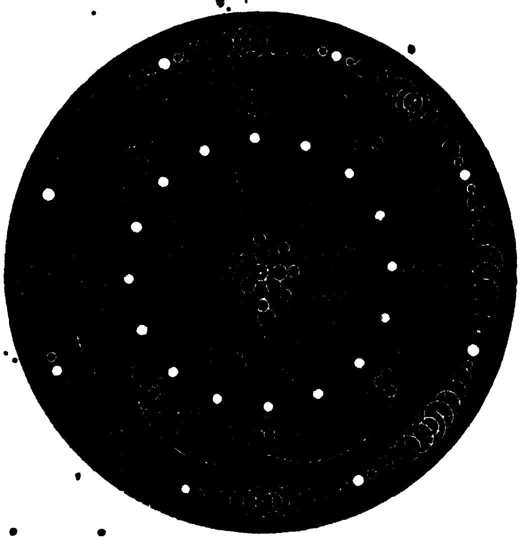
Fig. 1, is a representation of the eccentric chuck, seen when looking at its face; fig. 2, shows the same apparatus, seen sideways. The same letters refer to both.

A A is a plate of brass, a quarter of an inch or more in thickness, having a screw at the back of it, seen at O, in fig. 2, by which it is screwed on to the mandril of the lathe, in the same manner as any other chuck would be. B B are two slides of steel screwed down to the surface of A A, by two screws in each; the holes that admit the screws through B B being a little oval, in order that the slides may be adjusted so that they may always pass equably against the inner slider D, and be perfectly parallel to each other. To preserve them in their proper position, when once fixed, there are four screws, C C C C, which screw into four studs, left prominently standing upon the face of A, or else, as is more usually the case, the sides of A A which project beyond the slides B B are cut off, and then the screws C C C C are fixed in the sides of A, the prominent heads of them only bearing against B B. D is a plate of brass, which is made to slide smoothly between B B; it has upon the centre of it a wheel divided usually into 96 teeth, with a spring detent or click, as seen at G and H. This wheel passes through the plate D, and is so fastened that it is free to move round, and yet not out of its place, sideways, and above all things, so that it will not shake in its bed or bearings. The front of the toothed wheel has also a screw upon it, of the same thread as that of the mandril, seen in shadow at E, to which any of the usual common chucks are to be attached. The circular adjustments of the toothed wheel will be evident from the mere inspection of the figure. The lateral motion of the sliding piece D is occasioned by a screw towards the side as represented at I. This screw is made with a thread of about 20 turns to the inch; it is turned round at the square extremity I, by means either of the thumb and finger, or a small handle to be taken off and on at each adjustment. The screw is also furnished with a micrometer head divided into ten parts; for the sake of such minute alterations as may be necessary, a stud F, shows the proportion of the screw passed over; also the wheel E is numbered at every twelve teeth by the figures 12, 24, 36, &c. up to 96.

When the screw I is in one position, the screw E exactly corresponds to the centre of the lathe, and all the circles made are concentric, as in illustration the first.—If the tool be set to an extremely small distance from the centre it will make a small circle, at a greater distance a larger circle, and so on. Now, supposing it be set so as to cut the size of the smallest circle in example 3, and the screw I be turned once round, it would push the work out of the former centre, and a new one would be formed, making one of the circles in the inner row of example 3. Suffering the same adjustment of I continue, turn the wheel E round 12 teeth, and make a second circle, turn it 12 more teeth, and it will make a third circle equi-distant and of equal size to the first, thus making eight circles, which as is seen will touch one another. In the same manner all the others are made. If the tool be so adjusted as to make a large circle, as in the three groups of example 2, the circles will overlap each

other. If the tool be allowed to cut deep, and placed exactly in the centre, it acts as a drill and cuts a white dot, as in the larger example below. The tools employed for this kind of work, as well as the small slide rest necessary for their adjustment, we shall prepare an article upon, and explain more fully the nature and management of eccentric work.

The following is given as a general illustration of the character of it, which, however, may be modified and varied without end.



PHOSPHORIC METEORS.

Some attribute that luminous appearance which goes by the name of ignis fatuus to putrefaction. It is observed in boggy places, and near rivers, though sometimes also in dry places. By its appearance benighted travellers are said to have been sometimes misled into marshy places, bogs, and quagmires, taking the light which they saw before them for a candle at a distance. From this seemingly mischievous property, it has been thought by the vulgar to be a spirt of a malignant nature, and called *Will-with-a-wisp*, or *Jack-with-a-lantern;* for the same reason, also, it probably had its Latin name, *Ignis Fatuus.*

This kind of light is said to be frequent about burying places and dung-hills. Some countries are remarkable for it, as about Bologna, in Italy, and also in some parts of Spain and Ethiopia. Dr. Shaw, in his Travels to the Holy Land, says that it appeared in the valleys of Mount Ephraim, and attended him and his company for more than an hour. Sometimes it would appear globular, or in the shape of the flame of a candle, at others it would spread to such a degree as to involve the whole company in a pale inoffensive light, then contract itself, and suddenly disappear, but in less than a minute would appear again: sometimes running swiftly along, it would expand itself at certain intervals over more than two or three acres of the adjacent mountains. The atmosphere, from the beginning of the evening, had been remarkably thick and hazy; and the dew, as they felt it on the bridles of their horses, was very clammy and unctuous.

Lights resembling the ignis fatuus are sometimes to be met with at sea, skipping about the masts and rigging of ships; and Dr. Shaw informs us, that he has seen these in such weather as that just mentioned, when he saw the ignis fatuus in Palestine. Similar appearances have been observed in various other situations; and we are told of one which appeared about the bed of a woman in Milan, surrounding it, as well as her body, entirely. This light fled from the hand which approached it, but was at length entirely dispersed by the motion of the air.

These meteors are now considered as real exhalations from the earth, produced by gas, vapour, or some other attenuated substance, emanating from vegetable, animal, or mineral materials; and combined with the matter of light, or heat, or both. Instead of being dense or solid, they are uniformly rare and subtle; and, instead of originating in the loftiest regions of the atmosphere, or beyond its range, are generated, for the greater part, in low marshy plains or valleys. To the fearful and superstitious they are a source of terror.

In Italy, in the Bolognese territory, they are so frequent in the morassy grounds, that they are to be seen every night; some of them affording as much light as a kindled torch, and others not being larger than the flame of a candle, but all of them so luminous as to shed a lustre on the surrounding objects. They are constantly in motion, but this motion is various and uncertain. They sometimes rise, and at others sink, occasionally disappearing of a sudden, and appearing again in an instant in some other place. They usually hover about six feet from the ground, differing both in figure and size, and spreading out and contracting themselves, alternately. Sometimes they break, to appearance, into two parts; soon after uniting again in one body; at intervals they float like waves, letting fall portions of ignited matter, like sparks from a fire. They are more frequently observed in winter than in summer, and cast the strongest light in rainy and moist weather. They exist mostly on the banks of

brooks and rivers, and in morasses; but are likewise seen on elevated grounds, where they are, however, of a comparatively diminutive size.

In the month of March, 1728, a traveller being in a mountainous road, about ten miles south of Bonania, perceived, as he approached the river Rioverde, between eight and nine in the evening, a light shining very brightly on some stones which lay on the banks. It was elevated about two feet above them, its figure describing a parallelopiped, more than a foot in length, and about six inches high, its longest side lying parallel to the horizon. Its light was so strong that he could distinguish by it, very plainly, a part of a neighbouring hedge, and the water in the river. On a near approach, it changed from a bright red to a yellowish color, and on drawing still nearer became pale; but when the observer reached the spot it vanished. On his stepping back he not only saw it again, but found that the farther he receded, the stronger and more luminous it became. This light was afterwards seen several times, both in spring and autumn, precisely at the same spot, and preserving the same shape.

On the 12th of December, 1776, several very remarkable ignes fatui were observed on the road to Bromsgrove, five miles from Birmingham, a little before day-light. A great number of these lights were playing in an adjacent field, in different directions; from some of which suddenly sprang up bright branches of light, resembling the explosion of a rocket filled with many brilliant stars. In the case of the latter, the discharge was supposed to be upward or vertical, instead of taking the usual direction. The hedge, and the trees on each side, were strongly illuminated. This appearance continued a few seconds only, when the ignes fatui played as before. The spectator was not sufficiently near to observe whether the apparent explosions were attended with any report.

In the month of December, 1693, between the 27th and 30th, a fiery exhalation, without doubt generated in the same way with the meteors described above, set fire to sixteen ricks of hay, and two barns filled with corn and hay, at the village of Hartech, in Pembrokeshire. It had frequently been seen before, proceeding from the sea, and in these instances lasted for a fortnight, or three weeks. It not only fired the hay, but poisoned the grass, for the extent of a mile, so as to induce a distemper among the cattle. It was a weak blue flame, easily extinguished, and did not in the least burn any of the men who interposed their endeavours to save the hay; although they ventured, not only close to it, but sometimes into it. All the damage sustained happened, constantly, in the night.

Belonging to this class of meteors is the *draco volans*, a fiery exhalation, frequent in marshy and cold countries. It is most common in summer; and, although principally seen playing near the banks of rivers, or in boggy places; still it sometimes mounts up to a considerable height in the air, to the no small terror of the amazed beholders. Its appearance is that of an oblong, sometimes roundish, fiery body, with a long tail. It is entirely harmless, frequently sticking to the hands and clothes of spectators, without doing them the least injury.

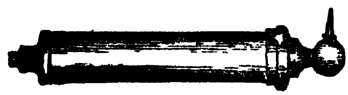
That curious phenomenon observed by Humboldt in South America, called the lantern of Maracaybo, is, undoubtedly, analogous to those meteors we have been describing.

BLOW-PIPES.

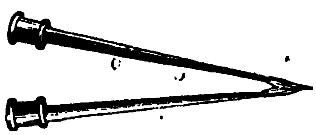
To the Editor.

SIR.—I read with great pleasure an article in page 322, Vol. I, of your excellent Magazine, on the oxy-hydrogen blow-pipe, invented by Mr. Gurney. Truly he is worthy of great praise for having put into the hand of the experimentalist so powerful an agent as the flame of the mixed gases. For this purpose Dr. Clarke had some years before invented the compression blow-pipe, but the risk in using it was so fearful as practically to forbid its adoption.

But however vast a stride was made in the construction of Mr. Gurney's instrument over the former plan, room was still left for further improvement; for in using this blow-pipe, if the pressure on the bladder be irregular, the flame is apt to recede through the chamber of wire gauze and asbestos, and blow out the cork of the water cistern; which circumstance, though unattended with danger, is sufficiently annoying to render an improvement desirable. This is in a great measure remedied by the jet, shown in Fig. 1, which was invented by Mr.

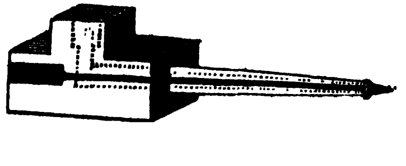


Hemmings. It consists of a cylinder about 4½ inches long and ¾ of an inch in diameter, with a screw at one end to attach the bag or bladder containing the mixed gases, and a jet at the other end, through which the gases issue and are burnt. The cylinder is filled with exceedingly fine brass wire, cut into lengths and made up into a bundle, and then forced into the body so as to occupy the whole of the interior. The gas which enters is obliged to pass through the capillary passages formed between the wires, which in ordinary cases is sufficient to prevent the flame from returning. But this jet is not in every case safe; and the risk that is always attendant upon having the gases in the same vessel rendered it desirable that some other plan should be devised, so as to enable them to be kept separate until they reached the point of combustion. This in part is accomplished by using the apparatus shown at Fig. 2, in which



the hydrogen passes through the one tube, and the oxygen through the other tube, consequently they do not mingle until they leave the points of the jets; thus perfect safety is attained, but the mixing of the gases is not complete.

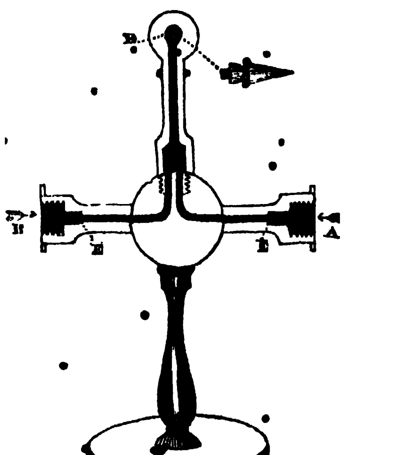
Another plan was to have two tubes, one inside the other, as shown in Fig. 3, in which the oxygen



enters at the end and passes up the centre tube, as shown by the dotted lines, and comes out at the jet; the hydrogen enters at the top and passes outside the oxygen tube, and comes out at the same jet; a cap is put over the end, and the gases pass out as usual.

This is in substance the jet of Professor Daniell, and Mr. Maugham. In both the last described jets the gases are contained in separate bladders or bags, which are connected by flexible tubes to the proper part of the jet. This last though very convenient is not free from danger, for if the pressure on either of the bags is taken off, or not equal to the other, the gas which is under the greatest pressure will be forced down the other tube, and render the contents of that bag explosive. This though apparently a trifling thing is not really so; for in two instances within my own knowledge, the bag thus circumstanced has exploded, and caused great destruction of property.

From these remarks it appears that to burn the gases with safety and yet with perfectness of mixture, it is necessary that the apparatus should be so arranged as to allow the gases to pass from the bladder or bags to the jet, but prevent any from returning. These desiderata are fully obtained in the jet constructed by Mr. Palmer, of Newgate-street, which is shown in section, in Fig. 4.



The end A is connected with one bag or bladder, and the end B with the other; the gases pass through the separate tubes, as marked, into the chamber (which is fitted with the finest wire gauze, and in filtering, as it were, through which the gases become perfectly mingled,) and from thence to the jet which is secured into the hole D. At E E are two conical valves, opening inwards, which allow a free passage for the gases in the direction indicated by the arrows, but which from the nicety of their construction instantly close, if there is any pressure in the opposite direction; so completely is this the case that the jet may be used for either gas separately, without screwing a cap into the other orifice. Thus are we in possession of a jet, at once convenient, safe, and at the same time ensuring a perfect mixture of the gases, without which a great portion of the effect is lost. EULON.

GROVE'S VOLTAIC BATTERY.

MR. W. R. GROVE, M.A., has constructed a small battery consisting of seven liqueur-glasses, containing the bowls of common tobacco-pipes; the metals, zinc and platinum; and the electrolytes, concentrated nitric and dilute muriatic acids. This little apparatus has produced effects of decomposition, equal to the most powerful batteries of the old construction. Mr. Grove has since tried various combinations upon the same principles, and though some of the rarer substances, such, for instance, as chloric acid, have produced powerful combinations, he has found none superior, and few equal to the above. Mr. Grove has, therefore, economized the materials; thus, on the side of the zinc, salt and water has been found little inferior to dilute muriatic acid; and it dispenses with the amalgamation of the zinc. By using flattened parallelopiped-shaped vessels, instead of cylindrical, the concentrated acid is much economized, the space diminished, and the metals approximated. (According to Prof. Ritchie, the power is inversely as the square root of the distance between the metals.)

A hastily-constructed battery, upon this principle, was presented to the British Association. It consisted of an outer case of wood, (glazed earthenware is better), 7½ in. by 5 and 3, separated into four flat compartments by glass divisions; into which are placed four flat porous vessels, measuring, in the interior, 7, 2½, and 3-10ths of an inch: they contain each three ounces, by measure; the metals, four pair, expose each a surface of 16 square inches; and the battery gives, by decomposition of acidulated water, 3 cubic inches of mixed gases per minute; charcoal points burn brilliantly; and it heats 6 inches of platinum wire 1-56th of an inch diameter; its effect upon the magnet, when arranged as a single pair, is proportionately energetic; it is constant for about an hour, without any fresh supply of acids. The porous vessels are identical in their constitution with the common tobacco-pipe. Its power, with reference to the common constant battery, is, *cæteris paribus*, as 6 to 1, but the proportions vary with the series. The cost of the whole apparatus is about 2*l.* 2*s.* During the operation of this battery, the nitric acid, by losing successive portions of oxygen, assumes, first a yellow, then a green, then a blue color, and, lastly, becomes perfectly aqueous; hydrogen is now evolved from the platina; the energy lowers, and the action becomes inconstant. This valuable instrument of chemical research is here made portable; and, by increased power in diminished space, its adaptation to mechanical, and especially to locomotive purposes, becomes more feasible.

ON ARSENIC,

CONTAINED NATURALLY IN THE HUMAN BODY.

M. ORFILA has read a memoir on the above subject before the Royal Academy of Medicine; the experiments detailed were made with M. Couerbe, and their object was to solve the following questions:

1st, Does arsenic exist originally in the human body? 2ndly. Do the viscera contain any? 3rdly, Can its existence in the muscles be proved? 4thly, Is it possible to determine that the arsenic obtained from a corpse is not that which originally existed among the elements composing the tissues, but was introduced into the digestive organs, applied to the exterior, &c.?

I. Arsenic exists in human bones; if the bones of an adult be calcined, taking care not to raise the temperature too high, and to avoid contact with the fuel, these bones, when reduced to powder and treated with purified sulphuric acid, and then tried in Marsh's apparatus, will yield brown, brilliant and thick arsenical spots. This result was obtained both from the bones of corpses of adults who had been dead some days, or buried for some months.

When the calcination is effected at a white heat, no arsenic is obtained, nor is any procured from the bones of commerce reduced to a soft paste; but if they be subjected to heat and the processes indicated (nitric acid, potash and sulphuric acid), a certain quantity of arsenic is obtained.

From this first series of experiment, which amount to fourteen, I conclude, says M. Orfila, 1st, That the bones of the human adult, of the horse, ox, and sheep contain minute portions of arsenic, which it is possible to discover by treating the bones with potash purified by alcohol and pure sulphuric acid.

2ndly, This quantity of arsenic is not increased by long burial.

3rdly, Vitrification removes a portion of it, which is undoubtedly occasioned by the volatilization which it occasions.

4thly, Among the conditions favorable to the discovery of arsenic must be especially reckoned that of not calcining the bones too strongly, and secondly, to avoid carefully the contact of fuel.

5thly, When bones are treated with water and ebullition, no arsenic is discoverable.

6thly, If in operating in this mode, any arsenic be detected, it has certainly been in some mode introduced into the economy.

II. No arsenic is found in the viscera unless it has been absorbed. The organs of a dog which was hung, treated by the usual processes, did not yield any. The blood, brain, the liver, spleen, kidneys, intestines, stomach, &c., gave no traces of it. Carbonized with nitric acid, and afterwards tried in Marsh's apparatus, white opaque spots only were obtained, and these were also produced without the presence of these organic matters.

The liver of an adult gave none; nor did the decoctions made with various organs yield any.

From these facts we may conclude, observes M. Orfila, but not positively, that the viscera do not originally contain arsenic; or to state the fact more accurately and not to prejudge the case, it may be asserted, that they do not yield any when treated with boiling water, sulphuretted hydrogen, or when carbonized by concentrated nitric acid, &c. It may so happen that the quantity is too small to be detected by sulphuretted hydrogen, or that it is lost by carbonization; but by acting on a large quantity of brain or other organs, it may be detected. At any rate, it is sufficient at present to have ascertained that the viscera yield no arsenic by the reactions described, unless it has been introduced by poisoning.

III. It is not proved that muscular flesh contains arsenic; twelve pounds of it taken from the corpse of an adult, carbonized by nitric acid and tested by Marsh's apparatus, gave white opaque spots; some were brilliant, with a blueish tint; others were yellow, and had an arsenical appearance; dissolved in boiling nitric acid, they gave no alliaceous smell when put on red-hot charcoal; in fact, they possessed none of the characteristics of arsenic. These spots were, however, very numerous; submitted for nearly twenty days to a current of sulphuretted hydrogen gas, they gave no indication of arsenic. It is possible that they were a mixture of arsenic and animal matter, and that the muscular flesh of two or three bodies might yield some by analysis; lastly, other processes may discover it in the same quantities as those employed, by occasioning less loss; therefore, adds M. Orfila, I will not conclude, positively, that arsenic does not exist in muscular flesh.

IV. It is possible to ascertain that the arsenic which may be discovered does not come from the organic substance itself, but that it has been combined with it by absorption. For if it be found in the bones, it will not be removed by long boiling in water, unless it had been introduced; and the same holds good with respect to the blood and the organs which have been examined.

Lastly, if the muscles yield spots, some of which resemble arsenic at first sight, the distinctive characters which have been stated must be remembered; and if the subject had taken arsenical remedies, this circumstance ought to be particularly attended to. —*Journal de Chim.*

PREPARATION OF GOLD-BEATER'S SKIN.

This manufacture requires the previous freeing of the muscular tunic from the other membranes which constitute the gut. Anatomists distinguish in it three membranes; viz., the external one, termed the *peritoneal;* the middle one, or *muscular* membrane; and the internal, or *mucous* membrane. Formerly, the guts were subjected to the putrid fermentation, in order to separate the peritoneal and mucous membranes from the muscular one; and this process was accompanied with such a fœtid effluvium, that the authorities obliged the manufacturers to establish their works at a distance from all other habitations. In 1820, the Prefect of Police, of Paris, proposed to the *Societè d'Encouragement*, to offer a prize for a process, either chemical or mechanical, of effecting this object without submitting the guts to the putrid fermentation.

After the guts have been freed from all greasiness, by the usual methods and turned inside out, they are to be put into a tub, capable of containing as many as are produced from fifty oxen; and two buckets of a weak alkaline liquor are to be poured upon them. If they should not be sufficiently wetted, throw over them another bucket-full of well or river water; they are then to be well stirred up, and left to steep all night. At the end of this time, the mucous membrane may be removed with as much facility as it could be after many days of putrid fermentation.

The other operations may be afterwards performed in the usual manner.

When the workman has stripped off that part of the peritoneal membrane which surrounds the *cæcum*, he takes from 2 to 2½ feet in length of it, and inverts it, or turns it inside out; he then leaves it to dry; when dry, it resembles a packthread. In this state it is sold to the manufacturer of gold-beater's skin, who takes the dried membranes and soaks them in a very weak solution of potash. When sufficiently soaked, so as to have become gelatinous, he places them on a wooden plank, to scrape them clean, and

cut them open with a knife. When the pellicles are well cleansed, and sufficiently freed from the water, they are extended on wooden frames, three or four feet long, and about ten inches wide; these are formed of two uprights, joined by two cross-pieces; the cross-pieces have grooves of three or four lines wide made in them.

In order to extend the membrane, the workman takes it in his hands, and affixes one end of it, by its glutinous quality, to the top of the frame, taking care that that part of the intestine which formed the outside of it be placed next to the frame: he then extends it every way, and causes it to adhere to the other end of the frame: this effected, he takes another membrane, and applies it upon that which is already extended, taking care that the muscular membranes should be in contact with each other: in this way they become so perfectly glued together as to form one solid body.

The two membranes soon become dry, except at their extremities, which are glued to the cross-bars of the frame. When the whole is well dried, the workman cuts the pellicles across at each end with a good knife, and separates them from the frame. The dried and stretched membranes are then delivered to another workman to give them the last preparation, and to cut them into convenient sizes.

In order to finish the pellicles, the workman takes each band separately, and glues it on a similar frame to that which we have before described, but without a groove: he applies the glue upon the edges of the frame, and places on it the band of a pellicle. When quite dry, it is washed over with a solution of one ounce of alum, dissolved in two wine-quarts of water, and again allowed to dry; it is then coated, by means of a sponge, with a concentrated solution of isinglass in white wine, in which acrid and aromatic substances have been steeped, such as cloves, musk, ginger, camphor, &c.: these last substances are added to prevent insects from attacking the pellicle. When sufficiently coated with this composition, or as the workmen call it, *grounded*, they, lastly, cover it with a layer of whites of eggs. The pellicle is then cut into pieces of about five inches square, submitted to the action of a press to flatten them, and then formed into small packets or books for sale to the gold-beaters.

DRYING SEA WEEDS.

BY J. S. DRUMMOND, M.D.

President of the Belfast Natural History Society.

THE first object to be attended to in preserving marine plants is to have them washed perfectly clean before spreading. There should not be left upon them a particle of sand or other foreign body, unless in some rare instances a parasitic species may be thought worthy of keeping, on account of its rarity, or because it may add an additional beauty to the chief specimen. It is a good practice to wash them before leaving the shore either in the sea, or in a rocky pool, or, as is sometimes more convenient in some localities, in a rivulet discharging itself into the ocean; though, as will be afterwards explained, the last practice proves very destructive to the beauty of some species.

The foreign bodies to be got rid of are fragments of decayed sea-weeds, sand, gravel, and sometimes portions of the softened surface of sandstone of argillaceous rock on which the specimens may have grown, together with the smaller testacea, and the *Corallina officinalis*, &c. At Cairnlough Bay I experienced most trouble in this respect from the *Ectocarpi*, which confervæ were so generally diffused as to be entangled with almost every other species of sea-plant.

After the greatest pains which we may take to clean our specimens at the shore, there will generally be found much to do before they can be properly committed to paper, since foreign substances will continue attached to them with much pertinacity even after we may have been satisfied that they are perfectly clean. It is therefore necessary to prepare each specimen by examining it in fresh or sea water in a white dish or plate, so that every thing foreign may be detected and removed.

The next thing to be attended to is the quality of the paper on which the specimens are to be spread; and here a great error is generally committed, in using it thin and inferior, by which, if the specimen be worth preserving, it has not proper justice done to it. Much of the beauty, indeed, of many species depends on the goodness of the paper, exactly as a print or drawing will appear better or worse, as it is executed on paper of a good or an inferior kind. Some species, too, contract so much in drying as to pucker the edges of the paper, if it be not sufficiently thick; for example, *Delesseria laciniata*, and this has a very unsightly appearance. That which I have from experience been led to prefer is thick music-paper. It closely resembles that used for drawing, and the sheet divides into four leaves, of a most convenient size.

Whatever pains we may have taken to clean the recent specimens, we shall often find, when spreading them, that some foreign particles continue attached, and for the removal of these a pair of dissecting forceps, and a camel-hair pencil of middle size, will be found convenient. These, indeed, are almost indispensable, and will be found useful on more occasions than can here be specified. A silver probe, with a blunt and a sharp end, is the most convenient instrument for spreading out, and separating branches from each other, but any thing with a rigid point, such as a large needle, or the handle of the camel-hair pencil sharpened, will answer. A large white dinner-dish serves perfectly well for spreading the specimens in, and all that is further necessary is a quantity of drying papers, and some sheets of blotting-paper, with three or four flat pieces of deal board. Nothing answers better for drying than old newspapers, each divided into eight parts, but it is necessary to have a large supply of these.

The beautiful and common *Plocamium coccineum* is one of the most easily preserved species, and may be taken as an example of the mode of proceeding with most of the others. The steps to be pursued are as follows:—

1. The specimen is to be perfectly well cleaned.
2. A dinner-dish is to be filled about two-thirds with clean fresh water.
3. The paper on which the specimen is to be spread to be immersed in the water in the dish.
4. The specimen to be then placed on the paper, and spread out by means of the probe and camel-hair pencil.
5. The paper with the specimen on it to be then slowly withdrawn from the dish, sliding it over its edge.

6. The paper with the specimen adhering to it to be held up by one corner for a minute or two, to drain off the water.

7. To be then laid on a paper, or cloth, upon a table, and the superfluous water still remaining to be removed by repeated pressure of blotting-paper upon the specimen, beginning this operation at the edges, and gradually encroaching towards the centre till the whole can be pressed upon without danger of any part adhering to the blotting-paper, which probably would be the case were the latter applied at once to the whole specimen.

8. The specimen then to be laid on a couple of drying papers placed on the carpet or a table; two more papers to be laid *over* it, and then the piece of board, on which latter a few books are to be put, to give the necessary pressure.

9. These papers to be changed every half hour or oftener, till the specimen is sufficiently dry. (A number of specimens with drying papers interposed may be pressed at once under the same board.)

Though the above method is in general the best, yet there are various species, and among these the *Plocamium coccineum* itself, which dry perfectly well by simple exposure to the open air without pressure being had recourse to at all; and some can only be preserved in the latter way, being so glutinous that they will adhere as strongly to the drying paper laid over as to that on which they are spread. Pressure, however, is necessary after they have dried, for the purpose of flattening them.

An indispensable requisite in the drying of marine or fresh water algæ is a portion of old rag, neither of a quality too fine or too coarse. When the specimen has been spread, as directed, upon the paper on which it is to remain, a piece of rag sufficient to cover it should be laid over, and then it may be interleaved under the boards for pressure. The rag prevents the necessity of so much care in taking up the moisture as Mr. Drummond requires, it never adheres to the specimens, but when dry leaves them, while most of the plants themselves stick firmly to the sheets on which they have been spread.

ON SECURING THE SCION IN GRAFTING.

BY D. POWELL, ESQ.

GRAFTING-WAX, properly prepared, when in a melted state, is spread evenly on sheets of moderately thin brown paper; which, when cold, is cut into slips about ¾ of an inch wide. When one of these slips is to be used, warm it with the breath, and bind it round the stock and scion, pressing it gently with the hand, when it will be found to adhere so closely as totally to exclude both air and moisture. No further trouble is necessary, though it may be as well to look over the grafts occasionally, pressing the paper close with the hand where it may have before been missed; but, after a few days' exposure to the warmth of the sun, it will generally be found adhering so closely, as to want no further attention. With the advantage of avoiding any unequal pressure of the bark, the neatness and convenience of this method will recommend it to the practice of amateurs; while its cheapness and utility will secure it a favorable reception with practical gardeners.

The grafting-wax is recommended by Miller, and also in the several Cyclopædias under the head of grafting, as composed of the following materials, with trifling variations as to proportion. One pound of pitch, one pound of resin, two pounds of bees' wax, four pounds of hogs' lard, and four pounds of turpentine, melted and well mixed together. By placing the composition in an earthen pan, over boiling water, it may be kept in such a state of fluidity as to be easily spread on the paper with a brush: heated in this manner, the wax appears to retain its pliability better than when exposed more immediately to the action of fire.

CHEAP FILTERING MACHINE.

THE best and cheapest filtering machine may be constructed as follows:—Procure a large stone bottle with the bottom knocked out, stop up the neck with small stones, over these form a layer of small pebbles, then another of gravel, increasing every layer in fineness, and putting on, lastly, a stratum of fine sand of the depth of several inches. The sand, gravel, &c. should of course be previously well washed, until the water runs off clear and tasteless. The common filtering stones are soon rendered unserviceable by the filling up of the pores; this apparatus on the contrary is a perpetual filtering machine, by merely taking out, occasionally, the upper stratum of sand, and washing it: it will also filter large quantities of water in a short time, of which the common filtering stones are wholly incapable.

VARIETIES.

Green from Coffee Berries.—At Venice a certain method has been lately discovered for composing a fine unchangeable emerald green color. A certain quantity of coffee is boiled in river water; spoiled coffee is preferable. By means of a proportionate quantity of pure soda a green precipitate is obtained, which is suffered to dry for six or seven days upon polished marble, stirring it about occasionally, in order that every part may come in contact with the atmosphere, from which it receives a new vivacity of tint. The green lake obtained by this process has resisted the action of the acids, and even the influence of light and moisture.

Mode of Lighting by means of a Self-generating Gas.—A communication has been made to the French Academy of Sciences by M M. Rouen and Busson on this subject. The substance employed is coal naphtha, an essence obtained from the distillation of the coal tar, which is one of the products of the distillation of coals for gas-lighting, producing a more perfect combustion of the naphtha than was ever before obtained by the apparatus of the lamp or burner; the gas is projected to some distance in the air before it takes fire, there being, however, within the tube of the burner a constant flame, which serves the double purpose of igniting the gas and decomposing the naphtha with which the lamp is supplied, generating new gas for continued combustion. The gas, being consumed at a short distance from the burner, is thoroughly supplied with air, and this free supply causes perfect combustion, and a brilliant light without smoke. The use of this light is attended with an economy of five-sixths as compared with oil, an equal quantity of light being furnished at a sixth of the expense.

GEOLOGY.

1. Granite.
2. Gneiss.
3. Micaceous Schistus.
4. Sienite.
5. Serpentine.
6. Porphyry.
7. Granular Marble.
8. Chlorite Schist.
9. Quartzose Rock.
10. Grauwacke.
11. Silicious Sand Stone.
12. Lime Stone.
13. Shale.
14. Calcareous Sand Stone.
15. Iron Stone.
16. Basalt.
17. Coal.
18. Gypsum.
19. Rock Salt.
20. Chalk.
21. Plum Pudding Stone.

A A. Primary Mountains.
B B. Secondary Mountains.
a a a. Veins.

GEOLOGY.

POSITION AND GENERAL ARRANGEMENT OF ROCKS.

At a time when geology engages so much of the attention of the scientific world, and to which it will be advisable occasionally to direct our readers' attention, it may be agreeable, and we are sure it will be useful, to give a paper pointing ont the general arrangement of the earth's strata, and the natural position of its rocks and mountains, as introductory to any future remarks which particular circumstances and discoveries may lead us to. The following, though not aiming at scientific classification, will, we trust, answer the purpose of communicating a general knowledge of the subject, intending at another period to explain each division more fully, and also to notice the organic remains discovered in certain of the strata.

Rocks are generally divided by geologists into two grand divisions, distinguished by the names of *primary* and *secondary*. The primary rocks are composed of pure crystalline matter, and contain no fragments of other rocks. The secondary rocks, or strata, consist only partly of crystalline matter; contain fragments of other rocks or strata; often abound in the remains of vegetables and marine animals; and sometimes contain the remains of land animals. The primary rocks are generally arranged in large masses, or in layers, vertical, more or less inclined to the horizon. The secondary rocks are usually disposed in strata, or layers, parallel, or nearly parallel to the horizon.

The number of primary rocks which are commonly observed in nature are eight.

First, *granite*, is composed of quartz, fieldspar, and mica; when these bodies are arranged in regular layers in the rock it is called *gneiss*.

Second, *micaceous schistus*, which is composed of quartz and mica arranged in layers, which are usually curvilineal.

Third, *sienite*, which consists of the substance called hornblende and fieldspar.

Fourth, *serpentine*, which is constituted by fieldspar, and a body named resplendent hornblende; and their separate crystals are often so small as to give the stone a uniform appearance. This rock abounds in veins of a substance, called *steatite*, or *soap rock*.

Fifth, *porphyry*, which consists of crystals of fieldspar, embedded in the same material, but usually of a different color.

Sixth, *granular marble*, which consists entirely of crystals of carbonate of lime; and which, when its color is white, and texture fine, is the substance used by statuaries.

Seventh, *chlorite schist*, which consists of chlorite, a green or grey substance, somewhat analogous to mica and fieldspar.

Eighth, *quartzose rock*, which is composed of quartz in a granular form, sometimes united to small quantities of the crystalline elements, which have been mentioned as belonging to the other rocks.

The secondary rocks are more numerous than the primary; but twelve varieties include all that are usually found in these islands.

First, *grauwacke*, which consists of fragments of quartz, or chlorite schist, embedded in a cement, principally composed of fieldspar.

Second, *siliceous sandstone*, which is composed of fine quartz or sand, united by a siliceous cement.

Third, *lime-stone*, consisting of carbonate of lime, more compact in its texture than in the granular marble, and often abounding in marine exuvia.

Fourth, *aluminous schist*, or *shale*, consisting of the decomposed materials of different rocks cemented by a small quantity of ferruginous or siliceous matter, and often containing the impressions of vegetables.

Fifth, *calcareous sand-stone*, which is calcareous sand, cemented by calcareous matter.

Sixth, *iron-stone*, formed of nearly the same materials as aluminous schist, or schale, but containing a much larger quantity of oxide of iron.

Seventh, *basalt* or *whin-stone*, which consists of fieldspar and hornblende, with materials derived from the decomposition of the primary rocks. The crystals are generally so small as to give the rock a homogeneous appearance, and it is often disposed in very regular columns, having usually five or six sides.

Eighth, *bituminous* or *common coal*.

Ninth, *gypsum*, the substance so well known by that name, which consists of sulphate of lime, and often contains sand.

Tenth, *rock salt*.

Eleventh, *chalk*, which usually abounds in remains of marine animals, and contains horizontal layers of flints.

Twelfth, *plum-pudding-stone*, consisting of pebbles cemented by a ferruginous or siliceous cement.

To describe more particularly the constituent parts of the different rocks and strata will be little understood, unless the specimens could be examined by the eye; and a close inspection and comparison of the different species, will, in a short time, enable the most common observer to distinguish them.

The highest mountains in these islands, and indeed in the whole of the old continent, are constituted by granite; and this rock has likewise been found at the greatest depths to which the industry of man has as yet been able to penetrate; micaceous schist is often found immediately upon granite; serpentine or marble upon micaceous schist; but the order in which the primary rocks are grouped together is various. Marble and serpentine are usually found uppermost; but granite, though it seems to form the foundation of the rocky strata of the globe, is yet sometimes discovered above micaceous schist.

The secondary rocks are always incumbent on the primary; the lowest of them is usually grauwacke; upon this lime-stone or sand-stone is often found, coal generally occurs between sand-stone or shale; basalt often exists above sand-stone and lime-stone; rock salt almost always occurs associated with red sand-stone and gypsum. Coal, basalt, sand-stone, and lime-stone, are often arranged in different alternate layers, of no considerable thickness, so as to form a great extent of country. In a depth of less than 500 yards, eighty of these different alternate strata have been counted.

The veins which afford metallic substances are fissures, vertical, or more or less inclined, filled with a material different from the rock in which they exist. This material is almost always crystalline, and usually consists of calcareous spar, flour spar, quartz, or heavy spar, either separate or together. The metallic substances are generally dispersed through, or confusedly mixed with these crystalline bodies. The veins in hard granite seldom afford much useful metal; but in the veins in soft granite, and in gneiss, tin, copper, and lead are found. Copper and iron are the only metals usually found in

the veins in serpentine. Micaceous schist, sienite, and granular marble, are seldom metalliferous rocks. Lead, tin, copper, iron, and many other metals, are found in the veins in chlorite schist. Grauwacke, when it contains few fragments, and exists in large masses, is often a metalliferous rock. The precious metals, likewise iron, lead, and antimony, are found in it; and sometimes it contains veins, or masses of *stone coal*, or coal free from bitumen. Lime-stone is the great metalliferous rock of the secondary family; and lead and copper are the metals most usually found in it. No metallic veins have ever been found in shale, chalk, or calcareous sand-stone, and they are very rare in basalt and siliceous sandstone.

In cases where veins in rocks are exposed to the atmosphere, indications of the metals they contain may be often gained from their superficial appearance. Whenever fluor spar is found in a vein there is always strong reason to suspect that it is associated with metallic substances. A brown powder at the surface of a vein always indicates iron, and often tin; a pale yellow powder lead; and a green color in a vein denotes the presence of copper.

It may not be improper to give a general description of the geological constitution of Great Britain and Ireland. Granite forms the great ridge of hills extending from Land's End through Dartmoor into Devonshire. The highest rocky strata in Somersetshire are grauwacke and lime-stone. The Malvern hills are composed of granite, sienite, and porphyry. The highest mountains in Wales are chlorite schist, or grauwacke. Granite occurs at Mount Sorrel in Leicestershire. The great range of the mountains in Cumberland and Westmoreland are porphyry, chlorite, schist, and grauwacke, but granite is found at their western boundary. Throughout Scotland the most elevated rocks are granite, sienite, and micaceous schistus. No true secondary formations are found in South Britain, west of Dartmoor, and no basalt south of the Severn. The chalk district extends from the western part of Dorsetshire to the eastern coast of Norfolk. The coal formations abound in the district between Glamorganshire and Derbyshire; and likewise in the secondary strata of Yorkshire, Durham, Westmoreland, and Northumberland. Serpentine is found only in three places in Great Britain; near Cape Lizard in Cornwall, Portsoy in Aberdeenshire, and in Ayrshire. Black and grey granular marble is found near Padstow in Cornwall; and other colored primary marbles exist in the neighbourhood of Plymouth. Colored primary marbles are abundant in Scotland; and white granular marble is found in the Isle of Sky, in Assynt, and on the banks of Loch Shin in Sutherland: the principal coal formations in Scotland are in Dumbartonshire, Ayrshire, Fifeshire, and on the banks of the Brora in Sutherland. Secondary limestone and sand-stone are found in most of the low countries north of the Mendip hills.

In Ireland there are five great associations of primary mountains; the mountains of Morne in the county of Down; the mountains of Donegal; those of Mayo and Galway, those of Wicklow, and those of Kerry. The rocks composing the four first of these mountain chains are principally granite, gneiss, sienite, micaceous schist, and porphyry. The mountains of Kerry are chiefly constituted by granular quartz, and chlorite schist. Colored marble is found near Killarney, and white marble on the western coast of Donegal. Lime-stone and sand-stone are the common secondary rocks found south of Dublin. In Sligo, Roscommon, and Leitrim, lime-stone, sand-stone, shale, iron-stone, and bituminous coal are found. The secondary hills in these countries are of considerable elevation, and many of them have basaltic summits. The northern coast of Ireland is principally basalt; this rock commonly reposes upon a white lime-stone, containing layers of flint, and the same fossils as chalk, but it is considerably harder than that rock. There are some instances in this district in which columnar basalt is found above sand-stone and shale, alternating with coal. The stone-coal of Ireland is principally found in Kilkenny, associated with lime-stone and grauwacke.

PROCESS OF THE DAGUERREOTYPE.

It is pretty generally known that although the French government have bestowed upon M. Daguerre a handsome annuity, for the public use of his extraordinary invention, yet he has taken out a patent to prevent the use of it in this country, not in his own name, but in that of a Mr. Berry; in consequence of which it is forbidden for any one to make specimens for sale, or to exhibit and instruct others in the process whereby the operation is conducted. We are, however, allowed to promulgate the entire and minute process, and this we do in the words of the patent, that our country subscribers may know the exact and authentic manner in which Daguerreotype pictures may be obtained, or made by themselves. The patent says thus:—

Description of the Process.—The reproduction of the images received at the focus of the camera obscurâ is effected on plates or surfaces of silver, which may be plated in copper. The copper serving to support the surface or sheet of silver, and the combination of these two metals contributing towards the perfection of the effect. The silver employed should be without alloy, or as pure as possible. The sheet of copper should be sufficiently thick to preserve the perfect smoothness and flatness of the plate, so that the images may not be distorted by the warping thereof, but the copper should not be thicker than what would be required to attain that end on account of the weight of the metal. The thickness of the two metals united need not to exceed that of a stout card. The process is divided into five operations:—The first consists in polishing and cleaning the silver surface of the plate, in order to properly prepare or qualify it for receiving the sensitive layer or coating upon which the action of the light traces the design. The second operation is the applying that sensitive layer or coating to the silver surface. The third in submitting, in the camera obscura, the prepared surface or plate to the action of the light, so that it may receive the images. The fourth in bringing out or making appear the image, picture, or representation, which is not visible when the plate is first taken out of the camera obscura. The fifth and last operation is that of removing the sensitive layer or coating, which would continue to be affected, and undergo different changes from the action of light—this would necessarily tend to destroy the design or tracing so obtained in the camera obscura.

Preparing the Surface.—For this operation are required a small phial of olive oil; some cotton very finely carded; a small quantity of pounce or pumice powder, ground extremely fine, and tied up in a

small bag of muslin, sufficiently thin in texture to allow the powder to pass easily through when the bag is shaken; a phial of nitric acid, diluted with pure water in about the proportion of one part of acid to sixteen parts of distilled water; a wire frame or stand on which the plates can be placed so as to be heated by means of a lamp; lastly, a spirit or other lamp to heat the plates. The size of the plates or surfaces are limited by the dimension of the apparatus—the plates must first be well cleaned and polished. To effect this, begin by sprinkling the silver surface with very fine dry pounce, then with cotton impregnated with a little olive oil, rub it gently on, lightly moving the hand round in circles from the centre. The plates during this operation should be placed flat on sheets of paper, which must be changed when necessary. The pounce must be sprinkled several times, and the cotton changed several times during the operation of rubbing. The pestle and mortar used for pulverizing the pounce or pumice powder should not be formed either of cast-iron or copper, but made of porphyry. The pounce should be ground afterwards on a glass plate with a glass muller, pure water being used in the operation. The pounce should be used only when perfectly dry. It will be readily conceived how important it is that the pounce or pumice powder should be sufficiently finely pulverized, so as not to cause streaks or scratches on the silver surface, for it is in a great measure upon the fine polish of the surface of the plate that depends the beauty of the image, picture, or tracing produced thereon. When the plate is perfectly polished it must then be cleaned. This is effected by dusting or sprinkling the powder over the surface, and rubbing it with dry cotton, the movements of the hand being made in circles, and backwards and forwards, and up and down, crossing each movement in order to operate fully on all parts of the surface. This is the best mode of rubbing to gain the desired result. Next a small knot or tuft is made with carded cotton, which is to be moistened with a little nitric acid, diluted in six times as much water. To do this, the knot of cotton may be placed on the mouth of the bottle containing the diluted acid, and pressed thereon—the phial being then inverted and then placed again upright, so that the centre of the tuft of cotton may be moistened with acid without deeply impregnating it; very little acid is required, and care must be taken not to wet the fingers with it. With this tuft so charged with acid the surface must be rubbed, care being taken to carry the acid uniformly over all parts of the surface of the plate; the cotton should be changed several times, and the rubbing of the surface be made by moving the hand round and round, and crossing as before, so as to extend equally the acid, which, nevertheless, ought to do no more than cover slightly the surface of the plate. It will sometimes happen that the acid applied on the surface of the plate will be found to accumulate into small globules; these must be destroyed by changing the cotton, and by rubbing the plate gently, so as to spread evenly the acid, for on any places where the acid has been allowed to rest a time, or has not been laid evenly, it would form spots or stains. It will be seen that the acid is evenly spread upon the surface of the plate by its appearing covered with a uniform tint, or what may be called a thin veil or change of surface. The plate is finally to be sprinkled with pounce or pumice powder, and cleaned by slightly rubbing it with a piece of carded cotton; instead of ordinary pounce calcined Venetian tripoli may be used. The plate thus prepared is then to be submitted to a considerable degree of heat; to do this it is placed on a wire frame—the silver surface being uppermost. Under the plate is to be placed a lighted lamp, which is to be moved about so that the flame shall act equally upon all parts. When the plate has been submitted for about five minutes to this operation, (or until the heat has acted equally upon all parts of the plate,) it will be perceived that the surface of the silver has obtained a whitish tint, or coating, and then the action of the heat must cease.

This effect may be obtained by other means; for instance, the heat of lighted charcoal may be used, which may be preferable, as the operation will be sooner finished. In this case the wire frame is unnecessary, for the plate may be laid on the stove or held with tongs, the silver surface always being upwards, and it may be moved backwards and forwards on the furnace, so as to heat it equally throughout, until the silver surface becomes covered with a whitish tint, as above stated. The plate is next to be cooled rapidly, by placing it on a cold body or substance, such as a marble slab, or stone or metal surface; when cooled, it must be polished again. This may be quickly done, since it is only necessary to remove the white tint which has been formed on the silver surface. To effect this, the plate is to be sprinkled with pumice powder, and rubbed in a dry state with a portion of cotton; this should be done on the surface of the plate several times, taking care to change the cotton often. When the silver is well polished it is to be rubbed again with acid dissolved in water, and sprinkled with a little dry pounce powder, and rubbed slightly with a knot of cotton. The acid is then to be laid upon the plate, say three different times, care being taken to sprinkle each time the plate with powder, and to rub it dry and very lightly with clean cotton; care should be taken not to breathe upon the plate, or touch it with the parts of the cotton touched by the fingers, as the perspiration would produce spots or stains, and dampness of the breath or of the saliva would produce the same defects in the drawings. When the plate is not intended for immediate use or operation the acid may be used only twice upon its surface after being exposed to the heat. The first part of the operation may be done at any time: this will allow of a number of plates being kept prepared up to the last slight operation. It is, however, considered indispensable that just before the moment of using the plates in the camera, or re-producing the design, to put at least once more some acid on the plate, and to rub it lightly with pounce, as before stated. Finally, the plate must be cleaned with cotton from all pounce dust which may be on the surface or its edges.

(Continued on page 26)

RULING MACHINES

Are made on different principles, and at various costs. The old principle is a very expensive one, costing upwards of £100. For general purposes decent ones may be obtained for about £5, or even less. The object to be obtained principally by ruling machines is a succession of straight lines, for flat tints, as sections in machinery, skies, backgrounds, &c. In views sometimes a flat sky tint is ruled in, and the shapes of clouds worked out upon it, as may be seen on a close inspection. In order

to produce a flat tint it is essential that the lines, independent of their being perfectly parallel to each other, should also be of exactly the same space apart, otherwise a streaky appearance is produced. To effect this, as well as to produce a parallality of line, (though in reality lines are not parallel which do not preserve an equality of distance from one another,) a box is made to slide upon a bar; a motion is then produced by turning a screw a given distance—the box, to which is attached a diamond or cutting point, being drawn along the bar, a line is made upon the surface intended to be marked, and the box moved back to its original position. The screw being turned again, precisely the same distance, a motion corresponding to the previous one is produced—the box again traverses the bar, and the cutting point traces a second line by the side of the first. This is the common principle of ruling machines; the difference being that in some the bar is made to move, the substance marked upon remaining stationary,—while in others the bar is a fixture, and the motion is given to the material ruled.

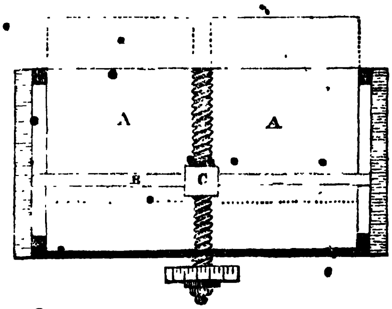


Fig. 1.

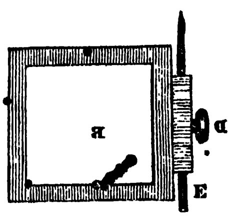


Fig. 1 illustrates the old-fashioned machine. A is the bed, or moving board, upon which the box slides. C is the sliding box; to this box the marking point is attached, but, as when the line has been cut by the point, it would be impracticable to move the sliding box back if the point were fixed, it is screwed to a nut which works on a centre in the side of the sliding box, so that when the point has arrived at the terminus of the line it is raised up, and the box then slides back to commence a fresh line. D is the circular nut in the side of the sliding box, working on its centre. E is the marking point, screwed to the circular nut. F is the screw by which the uniform motion is given to the bed of the machine; the width of line varying with the revolution of the screw—a half revolution of the screw producing a nearer tint of lines than a whole, a quarter than a half, and so on. The width is determined by a scale marked upon the screw.

The following is a more simple and less expensive principle than the preceding :—

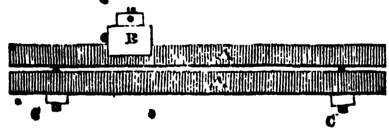
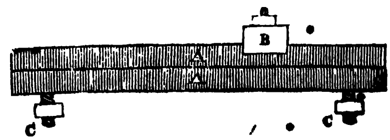


Fig. 2.



This machine, (fig. 2,) consists merely of two parallel bars, moving and stopping alternately. The width of line is regulated by a screw placed at each end. Instead of placing the plate to be ruled upon the machine, as in the first instance, the parallel rules are in this case placed upon the plate. The rules are screwed to the required width, placed upon the plate, and the box with the ruling point is drawn along the upper bar. The lower bar is then to be pushed close to the upper, and that in its turn is pushed forward—the screw regulating the distance of movement, and preserving a perfect equality in the width. A second line is ruled, and so on throughout — the same order of movement being observed.

A A represents the parallel bars. B the sliding box with the nut, similar to that in fig. 1. C C are the screws at each end, by which the width of line is regulated.

The upper figure has the bars extended to the width they are screwed to, and in the lower they are contracted previous to their extension again. The bars when used must, of course, be made to strike home each way, or the lines will not be equidistant. These machines are varied in size and shape, according to taste or convenience, as also is the way the screws are placed, the method of ascertaining the distance of lines, &c. With more complicated machinery greater accuracy is acquired, as well as greater neatness obtained. I have seen a machine tint ruled so exceedingly neat, that even on a very close inspection no lines could be observed, the tint appearing when printed precisely like a wash with Indian ink. There can scarcely be anything more simple for ruling than the last-mentioned machine, and for general purposes it might be made sufficiently accurate. I need hardly add, that when used the parallel bars should be pressed firmly down on the substance to be ruled, as the least tilting at either end of the bars would throw them out of the horizontal in ruling. These machines are for straight lines only, but the first, with a little more contrivance, can be made to rule lines in relief to represent the undulating surfaces of coins, medals, bas reliefs, &c.

GRAPHUS.

EGYPTIAN BLUE.

THIS color, which is very brilliant, is frequently found on the walls of the temples in Egypt, and also on the cases inclosing the mummies. The same color is found in the ruins of some ancient edifices in Italy, and even some of it has been been discovered

in the state it was made by the manufacturers for the painters in those remote times.

Count Chaptal analysed some of it, found in 1809, with several other colors, in a shop at Pompeii. He found that it was blue ashes, not prepared in the moist manner, like that which the paper-stainers use, but by calcination. He considers it a kind of frit, the semi-vitreous nature of which renders it proof against the action of the acids and alkalies at a moderate temperature.

Some years later, Sir H. Davy employed himself in Italy by making researches to ascertain the preparations of the colors used by the Greeks and Romans, and he obtained similar results; and further, by employing the synthetic method, he obtained a color similar to that of the ancients, by exposing to a strong heat, for two hours, a mixture of fifteen parts carbonate of soda, twenty parts of powdered flints, and three parts of copper. He thinks this is the blue described by Theophrastus, who has ascribed the discovery of it to a king of Egypt, and that it was manufactured at Alexandria.

Vitruvius, who calls this blue cœruleum, informs us that the art of making it was brought by Vestorus from Egypt to Puzzuoli, and that it was made by calcining, in a potter's furnace, balls made of sand, filings of copper, and flos nitri, (carbonate of soda.) The Venetians, who were so skilful in enamelling, knew how to prepare the Egyptian blue. Neri, in his Treatise, *Dell' Arte Vetaria*, describes different degrees of oxidation of copper, which gives these different colors, viz. red, green, and blue, and the color Arabico detto Turchino.

Although it appears that this color ought not to be employed in oil painting, yet it is much to be wished that we could recover the method of making it, as in distemper and decorative painting it would be of great utility. One remarkable effect of this color is, that by lamp-light it appears somewhat greenish, whilst by day it shines with all the brightness of azure: cobalt, on the contrary, becomes violet by artificial light.

It is thought that Paul Veronese has employed this sort of blue in many of his pictures in which the skies have become green. The blue ashes, as now prepared, would have experienced this change in a few weeks; while the Egyptian blue, which has remained almost without alteration as employed in distemper painting, would not for a long time become affected by the action of oil. Had Paul Veronese employed our blue ashes he would soon have discovered their want of solidity, and would not have exposed his works again to similarly injurious changes.

In Erdman's *Journal de Chimie*, Leipsic, 1822, the author assures us that he had succeeded in obtaining the finest blue, by means of glass colored by copper green. This substance was reduced to powder, then mixed with nitrate of potass, and then submitting the mixture to a heat not strong enough to melt it. When it has combined intimately, the color has become blue, but if fusion had taken place the matter would have been green.

One thing is surprising; it is that the spongy mass does not contain any more alkali in a free state, and is hardly touched by the acids. When it is finely ground it produces a brilliant celestial blue.

MR. SMEE'S GALVANIC BATTERY.

Of all the sciences that of galvanism has of late years made the most rapid strides. No sooner is one discovery registered than a second founded upon it is made known—no sooner is one fact ascertained than twenty others arise to support it. It is a remarkable and important circumstance that many of these discoveries should be in simplifying and increasing the power of apparatus, thus putting still greater opportunities in the hands of the operator. Formerly a galvanic battery was a stupendous, and an expensive machine, occupying a large space, and costing a considerable sum to keep it in its short-lived action. Now a far more powerful instrument may be made in a snuff-box, and carried in the pocket. These remarks are forced upon us by the astonishing platinum batteries of Mr. Grove, and the chemico-mechanical batteries invented by Mr. Smee, one of which is described by that gentleman as follows:—

The influence of different conditions of surfaces is a subject which has escaped all experimenters. Now this is singular, for many must have noticed that in a circuit the greatest quantity of gas is given off at the corners, edges, and points. Following this hint, a piece of spongy platinum, consisting as it does of an infinity of points, was placed in contact with amalgamated zinc, when a most violent action ensued, so that but little doubt could be entertained of its forming a very powerful battery. The fragile nature of this material precludes it from being thus used, and therefore it was determined that another piece of platinum should be coated with the finely-divided metal. This experiment was attended with a similar good result, and the energy of the metal thus coated was found to be surprising. To test the value of this process, a piece of platinum, thus platinized, was placed in dilute acid in contact with amalgamated zinc, and the quantity of gas evolved in a given time was noticed.

	Sq. Inch.		Com. Inch.
Platinized platinum	7	gave off	5 in 1 minute.
Platinum heated		ditto	1 in 1 minute.
Platinum covered by air..		ditto	3 in 6 minutes.

In these experiments the contact was made in each cell alike; the same zinc being used, and the distance being the same between the metals. The energy of the metal thus prepared upon the soft iron magnet is very great. A piece of platinum, exposing 32 square inches of surface, supports three-quarters of a pound through seventeen thicknesses of paper, whilst when smooth and wetted it supported it through eleven layers, and when no care was taken about its being wet, but when simply plunged into the liquid, only through five layers of the same paper. The cause of this increase of power appears to be the facility given to the evolution of the gas from the number of points, and not from an increase of surface, as but little benefit attends its application in the nitric acid batteries, in which the hydrogen is not evolved, but absorbed by the fluid.

Having ascertained that a solution of platinum must be used for increasing the power of metals in their ordinary state, it becomes a matter of great importance to ascertain whether the platinum may be precipitated upon other metals with advantage; and for this purpose it was deposited upon earthenware, palladium, pure silver, copper plated with silver, nickel, German silver, tin, lead, brass, cast iron, sheet iron, steel, zinc, and charcoal. The pla-

tinized earthenware was not found to answer, apparently from the quantity of the metal not being sufficient to carry the electricity. Palladium, silver, and plated silver answered equally well with platinum to receive the precipitated metal, and if there was any difference I think the silver was rather the best. Plated copper answers very well, but care should be taken to varnish every copper edge, or else that metal is apt to be slightly dissolved, and deposited again upon the platinized silver, which is injurious. Should copper, from any cause, get upon the silver, it may be dissolved by a little muriatic acid, and afterwards by a little strong ammonia. No other metal or alloy besides this answered for the reception of the platinum, except iron, and this was as active as silver for a time, but then a local battery was formed between the platinum and iron—the iron was dissolved, and the battery destroyed. In some cases this does not take place so rapidly as in others. Charcoal answers admirably for the reception of the platinum, and is improved in like manner.

We have now the elements for the manufacture of a powerful battery; for we have seen that increase of power is obtained by taking care that the negative metal is thoroughly wetted by the fluid, and that this is not only accomplished, but its power materially increased by the numerous points formed by the precipitation of finely-divided platinum. Whatever metal, alloy, or compound, may be found hereafter to succeed for the reception of the platinum, or whatever metal may be found to answer instead of the finely-divided platinum, still the principle by which the advantage is gained will be the same. However, the battery which I now propose is to be made of either copper plated with silver, palladium, or platinum. The silver can be rolled to any thinness, and is therefore not expensive. Each piece of metal is to be placed in water, to which a little dilute sulphuric acid and nitro-muriate of platinum is to be added. A simple current is then to be formed by zinc placed in a porous tube with dilute acid; when, after the lapse of a short time, the metal will be coated with a fine black powder of platinum. The trouble of this operation is most trifling—only requiring a little time after the arrangement of the apparatus, which takes even less than the description. The cost I find to be 6*d*. a plate, of 4 inches each way, or 32 square inches of surface. This finely-divided platinum does not adhere firmly to very smooth metals, but when they are rough is very lasting, and sticks so closely that it cannot be rubbed off. On this account, when either silver is employed, or copper coated with silver, the surface is to be made rough by brushing it over with a little strong nitric acid, which gives it instantly a frosted appearance, and this, after being washed, is ready for the platinizing process.

With regard to the arrangement of the metal thus prepared great diversity exists; it may be arranged in the same way as an ordinary Wollaston's battery with advantage—a battery thus constructed possessing greater power than Professor Daniell's. Four cells, containing 48 square inches in each cell, decomposed 7 cubic inches of mixed gas per five minutes, whilst four cells of Professor Daniell's, in which 65 square inches of copper were exposed in each cell, gave off only 5 cubic inches in the same time. However, in my battery thus arranged, the action dropped to 5 cubic inches in five minutes, but it resumed its power after the contact had been broken for a few seconds. The battery also possesses great heating powers, raising the temperature of a platinum or steel wire, 1 foot long, and of a thickness similar to that used for ordinary bird-cages, to a heat that could not be borne by the finger.

A small pot battery of six cells, fairly fused into globules, 2 inches of iron wire, and the combustion of different metals was extremely brilliant, when the battery was in combination with a Bachhoffner's apparatus. A small piece of silver platinized, (2 inches each way,) with a fold of zinc, was connected with a large temporary horse-shoe magnet, when it supported upwards of three hundred weight. Its magnetic power is not less astonishing—three cells supporting the keeper of a magnet through forty-five, two cells through thirty-two, and one cell through twenty thicknesses of paper. An electro-magnetic engine was made to rotate with great velocity, the combustion of the mercury at the breaking of contact being exceedingly brilliant.

A battery of this construction should be in every laboratory, to be used in most cases where a battery is wanted, and the slight labour attending its operation is scarcely worth mentioning. I have used one for forty-eight hours consecutively without the least alteration either of the fluid, or in the arrangement of the metals, and the diminution attending its operation appeared to arise from deficiency of acid, for it was instantly restored by a little strong sulphuric acid in each cell. Where the battery is required to possess the same power for a long period, it might be advisable to separate the metals by a porous earthenware vessel, or what answers the purpose equally well, by a thick paper bag, the joinings of which must be effected by shell-lac dissolved in alcohol. By these means the sulphate of zinc is retained on the zinc side of the battery. The use of porous tubes, however, appears from observation, as far as my battery is concerned, to be nearly superflous, at any rate in most cases; for I find, that after a battery, arranged as Wollaston's, had been at work in the same fluid for forty-eight hours, it had no zinc deposited on the silver. It is worth remarking, that during the last twenty-four hours contact had not been broken for a single instant. Notwithstanding these experiments, however, it may be as well in an extensive battery to use porous plates.

The battery may be arranged like the pot batteries, but I should greatly prefer the troughs, such as are used for Wollaston's batteries, from the convenience of packing, and from a battery of the same surface requiring so small a space. A battery may be constructed to form a most powerful calorimeter. It may also be arranged as a circular disc battery; or it may be made as a Cruickshanks, each cell being divided or not by a flat porous diaphragm. Whatever arrangement is adopted, the closer the zinc is brought to the platinized metal, the greater will be the power.

The generating fluid which is to be employed is water, with one-eighth of sulphuric acid by measure; and the zinc ought always to be amalgamated in the first instance, as that process will be found very economical from its stopping all local action, and the amalgamation will be found not to require repeating, because there is no fear of copper being thrown down on the zinc, which occasionally happens in the sulphate of copper batteries. The battery thus constructed is the cheapest and least troublesome in action that has ever been proposed, and from the smallness of its bulk will be found very valuable to electro-magneticians. It is second in power only to

the nitric acid batteries. For medical purposes, with a Bachhoffner's apparatus, a battery composed of platinized silver, 2 inches each way, will be found sufficient.

To recapitulate the processes of the formation of a battery: first, the platina, silver, or plated copper must be roughened, the two latter with nitric acid, and afterwards washed. The metal is next to be placed in an acid solution with a little nitro-muriate of platinum, which metal is to be thrown down by the formation of a simple galvanic circuit; and, lastly, the platinized metal is to be formed with amalgamated zinc into a battery, either with a porous tube or paper bag, or without them, according to the fancy of the operator, or the purpose for which it is wanted.

The advantage from this form of battery arises, as I believe, from a mechanical help to the evolution of the hydrogen, and therefore it is proposed to call it the chemico-mechanical battery. This battery may remain in the acid for a length of time, and neither the amalgamated zinc nor platinized silver will undergo the slightest change, and the whole will be as silent as death. Let only communication be made, the liquid in each cell becomes troubled;—it boils—it bubbles, and produces the effects which have been detailed. The quantity of electricity passing through either wires or liquids may be pretty accurately judged from the action taking place in the battery; for if the communication be made through a liquid of difficult decomposition, or through long small wires, (70 or 80 feet,) but little gas will be given off from the platinized metal, but when short thick wires are used the action is violent. A galvanometer might be constructed of one cell, as this would show the exact amount of electricity passing.

The importance of constructing a battery that shall be small in compass, efficient in action, cheap in its operation, and devoid of troublesome manipulation, is important in the highest degree; and I consider that my chemico-mechanical battery will be found frequently a useful means of obtaining gases for the oxy-hydrogen light. Its value for blowing up vessels under water, and exploding powder in mines, is sufficiently obvious.

BIRD-LIME.

The best bird-lime may be made from the middle bark of the holly, boiled seven or eight hours in water, till it is soft and tender, then laid by heaps in pits under ground, covered with stones after the water is drained from it. There it must be left during two or three weeks, to ferment in the summer season, and watered, if necessary, till it passes into a mucilaginous state. It is then to be pounded in a mortar to a paste, washed in running water, and kneaded till it be free from extraneous matters. It is next left for four or five days in earthen vessels to ferment and purify itself, when it is fit for use. Bird-lime may be made by the same process from the misletoe, young shoots of elder, and the barks of other vegetables, as well as from most parasite plants. Good bird-lime is of a greenish color, and sour flavor, somewhat resembling that of linseed oil; gluey, stringy, and tenacious. By drying in the air it becomes brittle, and may be powdered; but its viscosity may be restored by moistening it. It has an acid reaction with litmus paper. It contains resin, mucilage, a little free acid, coloring and extractive matter. The resin has been called *Viscine.*

MISCELLANIES.

Transplanting Trees.—Evelyn asserts that not one in a hundred of transplanted trees would miscarry if they were planted in the same aspect; that is, with that side which faced the south again towards the south. In Germany this point is not lost sight of; here it is little noticed, although it could be easily effected by marking, with a brush and a little white-wash, the trees, before removal, all on one side—say the south side. Mr. Maund also gives his testimony in favour of this practice.

Transparent Watch.—A watch has been presented to the Academy of Sciences, at Paris, constructed principally of rock crystal. It was made by M. Rebellier, and is small in size. The works are visible—the two teethed wheels which carry the hands are rock crystal, and the other wheels are of metal. All the screws are fixed in crystal, and all the axles turn on rubies. The escapement is of sapphire, the balance wheel of rock crystal, and its springs of gold. This watch is an excellent time-keeper, which is attributed by the maker to the feeble expansion of the rock crystal in the balance-wheel, &c.

Cooking Clock.—Mr. Loudon describes an egg clock which rings a bell, or sets off an alarum, at any number of minutes required. It is formed by a dial like that of a watch, but larger, surmounted by an alarum bell, and with five divisions, representing five minutes on the dial. This being fixed up over the kitchen fire-place, the index is moved to the number of minutes the egg is to be boiled; and, during the boiling, the cook may be otherwise employed till the alarum goes off. The act of moving the index, or pointer, backwards, winds up the clock. The principle may be applied to a larger dial, so as to mark the time requisite for cooking articles generally; and Mr. Loudon has accordingly caused such an apparatus to be made. Hence the ordinary work of the kitchen may go on without the interruption of watching, &c.

Improved Crayons for Drawing on Glass.—Melt together equal quantities of asphaltum and yellow wax; add lamp black, and pour the mixture into moulds for crayons. The glass should be well wiped with leather, and in drawing be careful not to soil the glass with the fingers. In trimming these crayons, if the edge be bevelled, like scissors, the point may easily be rendered very fine.

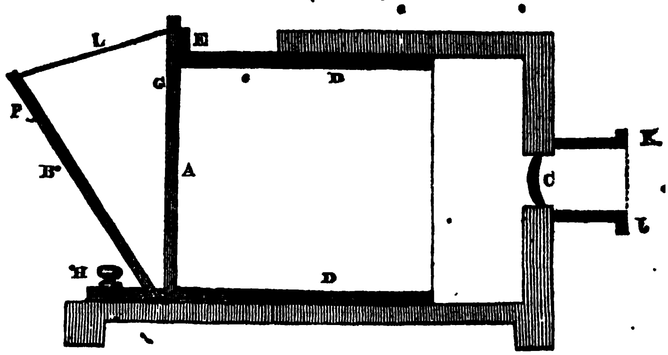
Fine Shoe Blacking.—Take 4 oz. of ivory black, 3 oz. of the coarsest sugar, a table-spoonful of sweet oil, and 1 pint of small beer—mix them gradually together cold.

Size for Artists.—Dissolve over the fire in a pint of water, 4 ounces of Flanders glue and 4 ounces of white soap; then add 2 ounces of powdered alum; stir the whole, and leave it to cool. This size is much used by those who have to color unsized paper, on which it should be spread cold, with a sponge or pencil.

To Cleanse Gold.—The best way is to wash it in warm suds, made of delicate soap, with ten or fifteen drops of sal-volatile.

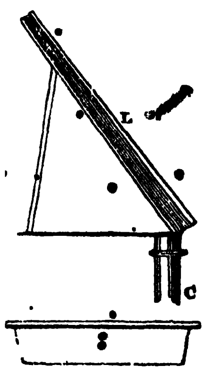
Cultivation of Orange Trees.—Re-pot the trees every sixteen or twenty-four years. The soil to consist of two parts cow-dung, two parts loam, three parts rotten horse-dung, and three parts of the old soil from the pots. They are to be occasionally watered, and fresh cow-dung is laid on the top of the soil every year as manure. The trees to be pruned in September in preference to the pruning in spring, by which three or four weeks are lost in their growth.

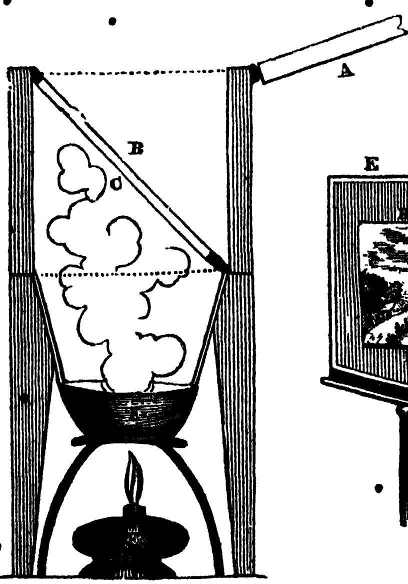
Fig. 2.



APPARATUS FOR THE DAGUERREOTYPE.

Fig. 3. 5.





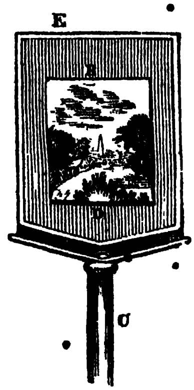


Fig. 6.

PROCESS OF THE DAGUERREOTYPE.

(Resumed from page 19, and concluded.)

Coating the Surface.—For this operation the following implements are required: a box, as represented in figure 1, and a phial of iodine.

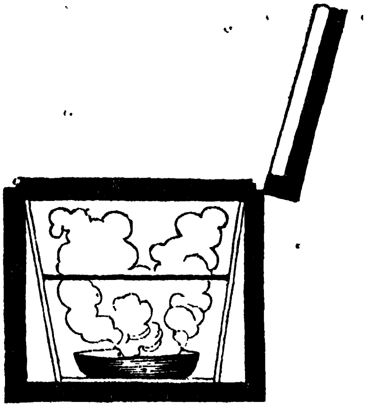


Fig. 1.

Some iodine is to be put into a cup dish and placed in the bottom of the box. It is necessary to divide the iodine into pieces, in order to render the exhalation more extensively and equally diffused; otherwise, on the middle of the plate would be formed circles, or a kind of iris, or appearance of a rainbow in prismatic colors, which would prevent the plate from receiving a uniform impression. A thin board with the plate fastened to it is then placed with the silver surface undermost, upon small brackets or supports, at the four angles of the box; its cover is then closed. In this position the plate must be left, until the surface of the silver be covered with a fine gold tinge, which is caused by the evaporation of the iodine, condensing upon the surface of the silver. If the plate were allowed to remain too long this golden yellow color would turn a purple or violet color, which must be avoided, because in this state the coating is not so sensitive to the effect of light. On the contrary, if this coating is too pale or not sufficiently yellow, the image taken from nature would be very deficiently or faintly reproduced, therefore a coating of a golden yellow is particularly desired, because it is the most favorable to the production of the effect. The time necessary for this operation cannot be stated, because it depends on several circumstances; one is the temperature of the room wherein the operation is conducted, and another the state of the apparatus; for this process should be left to itself, and not be affected by the addition of any other heat than that of the room.

It is very important in this operation that the temperature inside the box be equal to that outside; if such were not the case, on the plate being passed from a cold to a warm atmosphere, moisture would settle upon its surface, which would do great injury to the effect. This operation should be left entirely to the spontaneous evaporation of the iodine.

When the surface of the plate has attained the proper color, the board with the plate must be introduced into a frame which is adapted to the camera obscura. In this transference care must be taken to prevent the light striking on the surface of the plate, and for this purpose the camera obscura may be lighted with a wax taper, the light of which has much less effect upon the coated surface; even this light ought not to be allowed to strike too long on the plate, as it will cause marks or traces on the same, if allowed to continue a long time. After this second operation is completed, the plate is to be passed to the third operation, or that of the camera obscura. Whenever it is possible, the one operation should immediately follow or succeed the other. The longest interval between the two should not exceed an hour; beyond this time the action of the iodine and silver surface will lose their requisite photogenic properties.

Third Operation.—The apparatus necessary for this operation is the camera obscura, figure 2, adapted and fitted to receive the prepared plates and their boards. This third operation is that in which, by means of light acting through the lens of the camera obscura, nature reflects or impresses (to use figurative language) an image of herself of all objects enlightened by the sun, on the surface of the photographic or prepared plates. The objects (of which the image is to be retained upon the surface of the plate) should be as much as possible lighted by the sun, because then the operation is more expeditious. It is easy to conceive that this operation being produced only by the agency or effect of light, that the action is the more rapid according as the objects are more brilliantly lighted up or illuminated, or in their nature are more intensely white or present bright lines or surfaces. After having placed the camera obscura opposite to, or in front of the objects of which it is desired to fix or retain the image or obtain a representation, it is essential first to properly adjust the focus of the camera obscura, so that the objects be represented perfectly clear and distinct; this is easily done by moving forward or backward, the frame of a plate of ground glass in the camera, which glass receives the images of the objects from the lens. When this frame is brought to the proper position, this moveable part of the camera obscura is fixed, by means of screws applied for that purpose. The ground-glass is then removed from the instrument, care being taken not to move the camera obscura, and in the place of the ground-glass is substituted the apparatus carrying the prepared metallic plate or surface, which apparatus exactly fits the place of the ground-glass plate on its frame. During the time the apparatus with the prepared surface is being fastened into the instrument, by small brass buttons or other fastenings, the camera obscura is closed; the end is then opened by means of the two semicircles; the plate is then in a proper position to receive and retain the impressions of the images of the objects chosen upon being opened. Nothing more need be done but to open the aperture of the camera obscura, and to consult a watch to reckon the minutes the prepared surface shall be under the action of the light. This operation is of a very delicate nature, and should be carefully attended to, because nothing is visible, and it is quite impossible to state the time necessary for the reproduction of the image, as it depends entirely on the intensity of light received by or from the objects, the image of which is intended to be reproduced; the time may vary from three to thirty minutes. It is, however, very important not to allow more time to pass than what is necessary for the reproduction, because the clear parts would no longer be or remain white or clear, they would be

darkened by the prolonged action of the light allowed to strike upon the iodine on the surface. If on the contrary the time allowed is not sufficient, then the proof or image would be vague and without proper details. Supposing the operator has failed in one proof, it being imperfect on account of its having been withdrawn too soon or left to remain too long, another may be begun immediately, a plate having been previously prepared; the operator is then more certain of obtaining the proper effect, the second operation being corrected by the first. The plate or surface having been submitted to the action of the light the required time, we will describe the

Fourth Operation.—The Mercurial Process.—The operator must hasten to submit the surface of the plate to the fourth operation, as soon as it is withdrawn from the camera obscura. Not more than one hour ought to be allowed to expire between the third and fourth operations, and it is much more certain to obtain good proofs or tracings of nature, when the fourth operation takes place immediately after the third. For this operation are required the following implements: first, a phial containing a quantity of mercury or quicksilver; secondly, the apparatus afterwards to be described, represented in figure 3. The mercury is poured into the cup, situated in the bottom of the apparatus, and in a sufficient quantity to cover the ball or globe of a thermometer, inserted in the side of the box; from this time no daylight must be admitted, and the room must be darkened, and the light of a candle or taper only be used, to enable the operator to inspect the progress of the operation. The board on which is fixed the plate must be withdrawn from the apparatus already mentioned, as adapted in the camera, which apparatus preserves it from the contact of light. The thin board with the plate is then introduced in the grooves or ledges of the blackened board, B, fig. 3: this black board is then replaced in the box or apparatus, which maintains it at an inclination of forty-five degrees, the prepared metal surface being placed undermost, so that it may be seen through the side glass C. The cover A of the box must be put down gently, to prevent any particles of mercury flying about in consequence of the compression of the air. When the whole is thus prepared the spirit-lamp is lighted, and placed under the cup containing the mercury, and allowed to remain until the thermometer (the ball of which is immersed in the quicksilver bath, the tube extending outside the box) indicates a temperature of sixty degrees Centigrade, the lamp then must be removed. If the thermometer has rapidly risen, it continues to rise, even when the lamp is removed, but it should not be allowed to rise above seventy-five degrees Centigrade. The impressions of the image of nature now actually exists on the plate, but it is not visible; it is only after several minutes of time has elapsed, that faint tracings of the objects begin to appear as may be readily ascertained by inspecting the operation, or looking through the glass assisted by the light of a candle or taper, which must not be allowed to strike too long on the plate, because it would leave marks on the same. The plate should be left in the box; until the thermometer has fallen forty-five degrees, then the plate is to be taken out, and this operation is finished.

Fifth Operation.—Fixing the Tracing, Delineation, or Picture.—The object of the fifth operation is to remove from the surface of the plate, the coating of iodine, which otherwise on its being exposed too long to the action of light would continue to be decomposed, and would thereby destroy the picture or tracing. For this operation are required the following articles:—first, water saturated with sea-salt, or a weak solution of hypo-sulphate of pure soda; secondly, the apparatus represented in figs. 4 and 5, (one being a side view of the other) and two troughs, as shown in fig. 6. Into one of the troughs, the salt water is to be poured, until it is about an inch in depth, the other trough is to be filled with pure water; these two liquids are warmed or heated in temperature, though not to the boiling point. In place of the solution of salt may be substituted a solution of hypo-sulphate of pure soda; this latter is even preferable because it completely removes the iodine, which is not always the case when sea-salt is used, especially if the designs or tracings have been obtained some time, and laid aside between the fourth and fifth operations. The mode of operation, however, is the same for the two solutions; although the solution of hypo-sulphate does not require to be warmed, and a less quantity of it is required than of the salt and water, since it is sufficient that the plate should be covered with the same, when laid on the bottom of the trough. The plate is first to be immersed in the pure water contained in one of the troughs; it must only be dipped in and drawn out immediately, it is sufficient that the surface of the plate be covered with water, and then without allowing it dry, it is to be plunged immediately in the salt water. If the plate is not dipped in pure water before immersing it in salt water or in the solution of hypo-sulphate, these solutions would make marks or spots upon the surface of the plate. To facilitate the action of the salt water or of the hypo-sulphate which absorbs the iodine, the plate should be moved about in the liquid. When the yellow color or tint of the iodine is entirely removed from the surface of the plate, it is to be removed and carefully taken by the edges, so as not to touch or injure the drawing, and then dipped immediately in the first trough of pure water. The apparatus, shown in figs. 4 and 5, is then brought into use; these must all be perfectly clean, and a vessel or jug filled with distilled water, which should be hot, but not boiling. The plate, on being withdrawn from the trough of water, is to be placed immediately on the inclined plane F, fig. 4, and without allowing it time to dry. The operator is then to pour upon the surface bearing the drawing, the hot distilled water beginning at the top of the plate, and pouring the water over it in such manner that it shall flow over the surface, and carry away with it all the solution of sea-salt or of hypo-sulphate, which has been already considerably weakened by the immersion of the plate in the first trough. If the hypo-sulphate has been used, the distilled water to be poured over the surface need not be so hot as for the common salt solution. Not less than a quart of hot distilled water is required for thus washing the surface of a plate measuring eight or nine inches long, by six or seven inches wide. It sometimes will occur that after having poured warm water on the surface, some drops or globules of water will remain on the plate; in this case they must be removed before they have time to dry, as they might contain some particles of sea-salt or iodine and injure the drawing; they are readily removed by strongly blowing on the plate. It will be understood how important it is that the water used for this washing should be perfectly pure, for part

of it will dry on the surface of the plate, notwithstanding the rapidity with which it may have passed over it, and if it contains extraneous matter, then numerous and indelible spots would be formed on the drawing or tracing. In order to ascertain that the water is suited for this washing, a drop may be let fall on a burnished plate, and if, when evaporated by heat, it leaves no stain or mark behind, it may be employed without fear; distilled water is always sufficiently pure for this operation without testing it. When this washing is completed, the picture drawing or tracing is finished, the only thing now to be done is to preserve the surface from being touched, also from dust and from vapors which tarnish silver. The mercury which traces the images, or in other words by the action of which the images are rendered visible, is partly decomposed, it adheres to the silver, it resists the washing by the water poured upon it, by its adhesion, but it will not bear any rubbing or touching. To preserve these drawings they must be covered with glass, securely placed a little above the surface, both the edges of the glass and plate secured by pasted paper, or other means, and they are then unalterable even by the light of the sun.

Fig. 1, (page 26,) is a vertical section of the iodine box or apparatus, wherein the coating of iodine is obtained upon the silver surface. There is an interior cover closing the upper part of the box; it serves, when the apparatus is not in operation, to concentrate the evaporation of the iodine, which condenses on the wooden surface of this part of the box. Below is the cup for containing the iodine. Under the inner cover is the thin board to which is fixed the plate, the silver surface downwards; half way down is a disc or sieve of wire or other gauze, which is to be placed over the cup, in order to equalize the dispersion of the evaporation of the iodine. There is also a wooden lining formed with inclined sides, in the shape of a square funnel; this shape assists to diffuse equally the vapors of iodine, which spread as they rise.

The Camera Obscura.—Figure 2, is a vertical section taken through a camera obscura, adapted for the process of Daguerreotype or photogenic delineation, furnished with a frame for carrying the plate of ground glass, A. The distance this glass plate is to be from the object glass or lens is the same as the distance at which the surface intended to receive the image is placed. B, is a mirror for observing the effect of objects and selecting points of view; this mirror serves to enable the operator to choose the scenery, the image of which is to be reproduced. When the focus is properly adjusted, the thumb-screw, H, is turned to fix the parts in this position. The mirror is kept closed by means of two hooks at F, which take into small eyes at G; the frame and ground-glass plate is withdrawn, and in its place is substituted the frame carrying the prepared plate or surface. The object glass is achromatic and periscopic; the concave part must be outside of the camera obscura, its diameter is about three and a half inches, and its focus about thirteen inches.

Fig. 3, is a side view of the mercurial apparatus. A is the cover. B the black board with grooves to receive the board carrying the silver surface or metallic plate. E the cup, containing the mercury or quicksilver. F is the spirit-lamp.

Fig. 6, is a plan view of one of the troughs made of copper, tinned; two such troughs are required, one for the salt-water, and one for the pure water.

Fig. 4 and 5, is a representation of the washing apparatus, made of tin, varnished. To wash the designs on the plates they are placed on the stand or angular ledge, D. E is a ledge to conduct the water to the receptacle C.

CHEMICAL ELEMENTS.

HYDROGEN.

(*Resumed from page* 6)

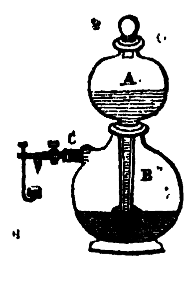
Ex. 18. *Hydrogen inflamed by the electric spark.*—Blow a soap bubble with hydrogen, and take the most minute spark through it, and it will be inflamed. The electrical cannon and pistol are modifications of this experiment.

Ex. 19. *Hydrogen inflamed by a red heat.*—Plunge in a small bottle of hydrogen gas an iron wire heated to complete redness; the gas will thereby be inflamed at the mouth of the bottle.

Ex. 20. *Musical sounds produced.*—Inflame the hydrogen gas which issues from the bottle where it is generated through a tobacco pipe fastened in the cork, and hold over it, so that the flame may be completely inclosed, a tube of glass about 2 feet long and 1 inch internal diameter. As the flame rushes up a strong musical sound will be produced, in tone according to the size of the column of air put in motion, or rather according to the size of the tube. If the tube be perforated with holes, like a flute, a tune may be produced. It is necessary that the flame should be as small as possible. The effect is produced by the succession of explosions and consequent vibrations occasioned by the combustion of the gas in the tube. Other flames besides that of hydrogen produce the same sound.

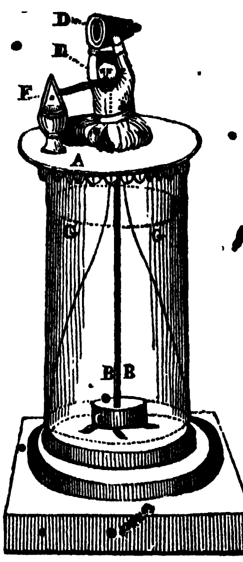
Ex. 21. *Renders certain metals red hot.*—Let a small stream of hydrogen gas fall upon platinum in a finely-divided state, or as it is then called *spongy platina.* The metal is almost immediately rendered red hot, and in its turn inflames the hydrogen. The same effect is produced upon palladium and iridium, though less perfectly, and also upon gold and silver leaf, if previously heated to 300° of temperature.

Ex. 22. *Hydrogen tinder box, or Dobereiner lamp.*—The peculiar property of hydrogen causing spongy platina to become red hot, and then becoming inflamed by it, has given rise to one of the most philosophical instruments for producing instantaneous light, and which may be made available for many purpose of chemical analysis. It is described thus: (see figure.)



A is a globular funnel-shaped vessel, fitted by a ground joint into the bottle B. The lower end of A, which is hollow, and which extends to very near the bottom of B, has placed upon it a cylinder of zinc, confined there by a cork beneath, which fits lightly. C is a tube fitted on to a second neck made to the bottle, and is furnished with a stop cock and jet,

to throw the hydrogen when made upon some spongy platina contained in a little cup beneath the jet. To charge this instrument with hydrogen, B is nearly filled with water previously mixed with one-sixth the quantity of sulphuric acid. The zinc is put on the pipe belonging to A, with the cork beneath it, and A put in its place. Hydrogen will now be generated, and a quantity occupy the part of B not filled with water; here acting with a pressure upon the water the latter is driven up the tube into A, and by this means the zinc is left bare, and no more hydrogen is formed. To procure a light, turn the stop cock, and the hydrogen will pass out in a very minute stream upon the platina; this will become red hot, and the hydrogen jet be inflamed—a match or candle may then be lighted by it. As the gas burns, the pressure in B is removed, the water again sinks, acts upon the zinc, and forms gas a second time, and so on till the whole is consumed. This instrument is sure and quick in its action, and is extremely valuable as a blow-pipe for chemical analysis, and particularly for working in glass. The following cut exhibits the same apparatus in a different and more elegant form. The construction is the same.



A represents a moveable top to a glass vessel, B B a rod to hold the lump of zinc C. D is a cover for the platinum box F. The jet of hydrogen issues from the figure's mouth E. G G shows the mixed acid and water driven up in the outer vessel when the inner one is loaded with gas. The arms of the figure move the plug of the stopcock, when the arms are lifted up the cock is opened; when shut down, the communication is closed.

(*Continued on page* 60.)

ARTIFICIAL PEARLS.

THIS elegant manufacture is of French origin, and is still carried on by that ingenious people in a superior manner. They are formed of thin glass bubbles, with their interior surfaces covered with a pearl-colored substance, which is thrown into them through a small tube. The substances employed for this purpose are the silvery scales of fishes, particularly those of the bleak; they are prepared by being well beaten in water; the silvery sediment next undergoes several ablutions, and is then mixed with transparent agglutinating matter, and in this state is employed for coating the bulbs. The inventor was a bead-maker of the name of Jacquin, who lived about the time of Henry the Fourth. This man observed, that on washing the scales of the bleak fish, a very beautiful silver-colored powder was obtained, and it occurred to him that by introducing this substance into the interior of finely blown glass beads, slightly tinged with opaline hues, a perfect imitation of real pearls might be made. Jacquin experienced considerable difficulty in preserving this silvery powder, which, if not speedily made use of, quickly became putrid, diffusing an intolerable smell. Attempts were made to preserve it in spirits, but this was found to have the effect of destroying its beautiful lustre. It was at length discovered that the volatile alkali possessed the power of preserving the substance without detriment to its lustre.

The Roman pearls are formed of a very pure alabaster, considerable quarries of which exist near Pisa, in Tuscany. The process is as follows:—The alabaster is first sawn into slices the thickness of the pearls required; the pearls are then formed with an instrument which bores a small hole in the centre at the same time that the required shape is obtained. The next thing in the process is their immersion in boiling wax to give them a rich yellow hue, and afterwards to cover them several times with the silvery substance obtained from the scales of the bleak. The singular beauty of this ornament, which perfectly resembles the real pearl; the varied patterns in which they are arranged, and their extreme cheapness, render them an object much sought after; while their solidity is such that they may be dashed to the ground with violence without receiving the slightest injury; being thus rendered far superior to those of French manufacture, which are at once more fragile, and considerably less imitative.

Chinese Pearls. — That ingenious people, the Chinese, in a manner, force the production of the article in the animal itself. They collect the *mya margaritifera*, or European pearl muscle, and pierce the outsides of the shells in several parts, without completing the perforation throughout. The animal becoming conscious of the weakness or deficiency of the shell in those particular spots, deposits over them a great quantity of its calcareous matter, and thus forms so many pearly tubercles over them. The pearls thus obtained are, however, said to be generally inferior to those naturally produced.

GLAZES FOR THE LATHE.

TAKE a piece of dry beech or other wood, from an inch to an inch and a half in thickness, and roughly shape it into a circular form of seven or eight inches diameter. Chisel a square hole in the middle, pass a wooden or iron axle through it, and wedge it firmly in. Centre this in the lathe and having turned down the edge with the gouge, smooth it with the chisel, and form it into the shade of a grindstone. Next procure a piece of buff leather, of the requisite breadth, and long enough to go exactly round. Brush the rim over with glue, and stick the leather neatly upon it, with the rough side towards the wood, and the edges ex-

actly meeting. Then glue the outside of the leather and sprinkle emery powder upon it. Let it remain two or three days till perfectly set, and it will be fit for use. In grinding with it, it is to be suspended in the lathe and swung round the contrary way to turning, and a pot of water should be at hand to dip the tools into when heated. A small grindstone fixed in the lathe in the same manner will be found very useful. If preferred, water may be easily made to drip upon it while revolving; but a trough cannot be employed, as the water would be splashed about by the velocity.

LANDSCAPE PAINTING.

LANDSCAPE painting comprehends all objects presented to our view in a prospect of the country, and is commonly divided into the *heroic* or *historical*, and the *rural* or *pastoral* styles; all others partake more or less of these. By the heroic style is understood those scenes which exhibit whatever is great, sublime, or extraordinary in nature or in art.

The rural style is a representation of countries rather abandoned to the caprice of nature than cultivated by man. A landscape comprehends a great variety of parts, such as *situations or openings, accidents, air, skies and clouds, offskips and mountains, verdure, rocks, fields, terraces, buildings, water, fore grounds, plants, trees and figures.*

Situations or Openings.—These are the *view* or prospect of a country, and require great skill in putting together.

Accidents.—Accidents in painting are various, such as an obstruction of the sun's light by the interposition of clouds, so that some parts of the prospect shall be enlightened, while others are obscured.

The Sky and Clouds.—In the language of the painter, the sky means the ethereal firmament above us. The sky is of a blue color, drawing more to a white as it approaches the earth, on account of the intervention of vapors arising between the eye and the horizon. It is to be observed, however, that this light being yellowish or reddish at sunset, those objects partake not only of the light but of the yellow or red color, consequently the yellow light mingling with the blue sky gives it a tint more or less greenish, as the yellowness of the light is more or less deep. The property of clouds is to be thin and airy both in shape and color; their shapes, though of endless variety, ought to be carefully observed and studied from nature. In order to make them look thin in a picture, the grounds over which they pass ought to be made to unite with them, as if the clouds were transparent, especially towards their edges. Small clouds in a painting seldom have a good effect, and betray a feebleness of manner in the artist, excepting when they are so near one to another as in a general way to be considered as forming only one object.

Offskips and Mountains.—Offskips have a near affinity with the sky, by which their strength or faintness is determined; the offskips are darkest when the sky is most loaded, and brightest when it is most clear. In representing the distances of mountains, care must be taken to round them off by proper gradations of tints, and to avoid edgeiness in their extremities, which makes them appear in slices.

Trees.—Beginners will find in practice that the chief trouble of landscape lies in handling trees; as they are the most difficult part of landscape, so are they its greatest ornament.

Painters usually comprise under the word *study*, any thing whatever which they either design or paint separately after the life; whether figures, heads, lands, draperies, animals, mountains, &c. As the landscape painter need only study such objects as are to be met with in the country, we would recommend to him some order that his drawings may be always at hand; when he wants them, he should copy from nature on separate papers the different effects of trees in general, with their trunks, foliage, and colors. He ought also to study the effects of the sky, in the several times of the day and seasons of the year. To improve themselves in these kind of studies, painters have taken several methods. There are some artists who have designed after nature in the open fields, and have there quite finished those parts which they had chosen, but without adding any color to them; others only draw the outlines of objects, and slightly washed over them colors for the advantage of their memory.

If it be asked which is the most proper time for these studies, the answer is, that nature should be studied at all times, because she is to be represented at all seasons, but autumn yields the most plentiful harvest for her fine effects; the mildness of the season—the beauty of the sky, and the variety of objects are powerful inducements with the painter for improving his genius and perfecting his art.

But as we cannot see or observe everything, it is not improper to make use of the studies of others. Raphael sent some young men into Greece, to design such things as he thought would be of service to him, and made use of them to as good purpose as if he himself had them always on the spot; for this, Raphael is so far from deserving censure that he ought on the contrary to be commended, as an example that painters ought to leave no way untried for improving in their profession. The landscape painter may accordingly make use of the works of all those who have excelled in any kind, in order to acquire a good manner; like the bees which gather their variety of honey from different flowers.

(*Continued on page* 62.)

ACTION OF COLORED LIGHT ON THE GROWTH AND GERMINATION OF PLANTS.

BY ROBERT HUNT, ESQ.

I PLANTED in a box some curled cress seed, and so arranged bottles of carmine fluid, chromate of potassa, acetate of copper, and the ammonia sulphate, that all but a small space of the earth was exposed to light which had permeated three-fourths of each of these media.

For some days the only apparent difference was that the earth continued damp under the green and blue fluids, whereas it rapidly dried under the red and yellow. The plumula burst the cuticle in the blue and green lights, before any change was evident in the other parts.

After ten days, under the blue fluid there was a crop of cress, of as bright a green as any which grew in full light, and far more abundant.

The crop was scanty under the green fluid, and of a pale unhealthy color.

Under the yellow solution but two or three plants appeared, yet they were less pale than those which had grown in green light. Beneath the red bottle the number of plants which grew was also small, although rather more than in the spot the yellow covered. They too were of an unhealthy color.

I now reversed the order of the bottles, fixing the red in the place of the blue, and the yellow in that of the green. After a few days' exposure the healthy cress appears blighted, while a few more unhealthy plants began to show themselves, from the influence of the blue rays, in the spot originally subjected to the red.

It is evident from this that the red and yellow rays not merely retard germination, but positively destroy the vital principle in the seed. Prolonged exposure uncovered, with genial warmth, free air, and indeed all that can induce growth, fails to revive the blighted vegetation.

I have repeated the experiment many times, varying the fluids, but the results have been the same. At this time I have the above facts strikingly exemplified where the space covered by the bichromate of potassa is without a plant.

These results merit the attention of those who are engaged in the study of vegetable economy. Do they not point at a process by which the productions of climes more redolent of light than ours may be brought in this island to their native perfection?

VARNISHING.

(*Resumed from page 8.*)

Turpentine Copal Varnish.

3 oz. of copal, liquefied, and
23 oz. of oil or essence of turpentine.

Place the matrass containing the oil in a *balneum mariæ*, and when the water boils, add the pulverized copal in small doses. Keep stirring the mixture, and add no more copal till the former be incorporated with the oil. If the oil, in consequence of its particular disposition, can take up 3 ounces of it, add a little more; but stop if the liquid becomes nebulous, then leave the varnish at rest. If it be too thick, dilute it with a little warm essence, after having heated it in the *balneum mariæ*. When cold, filter it through cotton, and preserve it in a clean bottle.

This varnish has a good consistence, and is as free from color as the best alcoholic varnish. When extended in one stratum over smooth wood, which has undergone no preparation, it forms a very brilliant glazing, which, in the course of two days, in summer, acquires all the solidity that may be required.

The facility which attends the preparation of this varnish by the method here indicated, will admit of its being applied to all colored grounds which require solidity, pure whites alone excepted; painted boxes, therefore, and all small articles, colored or not colored, whenever it is required to make the veins appear in all the richness of their tones, call for the application of this varnish, which produces the most beautiful effect, and which is more durable than turpentine varnishes composed with other resinous substances.

Fat Amber, or Copal Varnish.

4 oz. of amber or copal of one fusion,
10 oz. of essence of turpentine, and
10 oz. of drying linseed oil.

Put the whole into a pretty large matrass, and expose it to the heat of a *balneum mariæ*, or move it over the surface of an uncovered chaffing-dish, but without flame, and at the distance from it of two or three inches. When the solution is completed, add still a little copal or amber to saturate the liquid; then pour the whole on a filter prepared with cotton, and leave it to clarify by rest. If the varnish is too thick, add a little warm essence to prevent the separation of any of the amber.

This varnish is colored, but far less so than those composed by the usual methods. When spread over white wood, without any preparation, it forms a solid glazing, and communicates a slight tint to the wood.

If it be required to charge this varnish with more copal, or prepared amber, the liquid must be composed of two parts of essence for one of oil.

Compound Mastic Varnish.

32 oz. of pure alcohol,
6 oz. of purified mastic,
3 oz. of gum sandarac,
3 oz. of very clear Venice turpentine, and
4 oz. of glass, coarsely pounded.

Reduce the mastic and sandarac to fine powder; mix this powder with white glass, from which the finest parts have been separated by means of a hair sieve; put all the ingredients, with alcohol, into a short-necked matrass, and adapt to it a stick of white wood, rounded at the end, and of a length proportioned to the height of the matrass, that it may be put in motion. Expose the matrass in a vessel filled with water, made at first a little warm, and which must afterwards be maintained in a state of ebullition for one or two hours. The matrass may be made fast to a ring of straw.

When the solution seems to be sufficiently extended, add the turpentine, which must be kept separately in a phial or pot, and which must be melted by immersing it for a moment in a *balneum mariæ*. The matrass must be still left in the water for half an hour, at the end of which it is taken off; and the varnish is continually stirred till it is somewhat cool. Next day it is to be drawn off, and filtered through cotton. By these means it will become exceedingly limpid.

The addition of glass may appear extraordinary, but this substance divides the parts of the mixture, which has been made with the dry ingredients, and it retains the same quality when placed over the fire. It therefore obviates with success two inconveniences, which are exceedingly troublesome to those who compose varnishes. In the first place, by dividing the matters, it facilitates the action of the alcohol; and in the second its weight, which surpasses that of resins, prevents these resins from adhering to the bottom of the matrass, and also the coloration acquired by the varnish when a sand-bath is employed, as is commonly the case.

The application of this varnish is suited to articles belonging to the toilette, such as dressing-boxes, cut paper-works, &c. The following possesses the same brilliancy and lustre; but it has more solidity, and is exceedingly drying.

Camphorated Mastic Varnish for Paintings.

12 oz. of mastic, cleaned and washed,
$1\frac{1}{2}$ oz. of pure turpentine,
$\frac{1}{2}$ oz. of camphor,
5 oz. of white glass, pounded, and
36 oz. of ethereous essence of turpentine.

Make the varnish according to the method indicated for compound mastic varnish before described. The camphor is employed in pieces, and the turpentine is added when the solution of the resin is completed. But if the varnish is to be applied to old paintings, or paintings which have been already varnished, the turpentine may be suppressed, as this ingredient is here recommended only in cases of a first application to new paintings, and just freed from white of egg varnish.

The etherous essence recommended for varnish is that distilled slowly, without any intermediate substance. The question by able masters, respecting the kind of varnish proper to be employed for paintings has never yet been determined. Some artists, who have paid particular attention to this object, make a mystery of the means they employ to obtain the desired effect. The real end may be accomplished by giving to the varnish, destined for painting, pliability and softness, without being too solicitous in regard to what may add to its consistence or its solidity. The latter quality is particularly requisite in varnishes which are to be applied to articles much exposed to friction, such as boxes, furniture, &c.

To make Painter's Cream.—Painters who have long intervals between their periods of labor, are accustomed to cover the parts they have painted with a preparation which preserves the freshness of the colors, and which they can remove when they resume their work. This preparation is as follows:—

3 oz. very clear nut oil,
½ oz. mastic, in tears, pulverized, and
½ oz. sal saturni, in powder, (acetate of lead.)

Dissolve the mastic oil over a gentle fire, and pour the mixture into a marble mortar over the pounded salt of lead; stir it with a wooden pestle, and add water in small quantities, till the matter assume the appearance and consistence of cream, and refuse to admit more water.

Continued on page 53.)

METHOD OF PRESERVING MOSSES.

(To the Editor.)

SIR.—Having often admired the beauty and elegance of some of our mosses, and regretting that I knew of no method by which they could when gathered be preserved, so as to retain any considerable portion of their natural appearance, I was induced, in order to effect this desirable object, to make trial of the following simple plan, which has succeeded beyond expectation.

The piece of moss to be preserved should first be cleansed of all dirt and extraneous matter; it should then be thoroughly wetted with distilled water, and placed in a preparation jar or wide mouthed bottle, in which also a little of the water should be put—a few drops is sufficient, the object being to produce a damp atmosphere around the plant, which is effected by the continual evaporation and re-condensation of the water in the jar, this of course being so secured as to prevent the escape of any portion of the water.

By this process the moss will be found to preserve both its form and color. I have now tried it for a period of six months, and the specimens remain unchanged, as fresh and as green as the first day they were gathered. A moderate temperature is the most suitable. A. HASSELL.

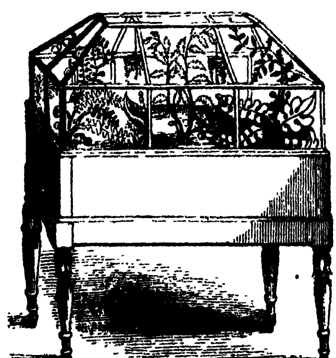
MISCELLANIES.

Porosity of Cotton.—Fill a glass tumbler completely with some spirit, so that a few more drops would cause it to overflow. This done, you will find no difficulty in introducing into the tumbler, so filled, *a whole handful of raw cotton.* This experiment was suggested by the accidental recovery of some wet cotton from a boat which had been some time sunk in a river in America; when it was found that after the water was squeezed from the cotton, the vessel which had contained it remained nearly as full as before the cotton was removed. Spirits answer much better than water for this experiment, from the rapidity with which they are absorbed by the cotton. Several theories have been started in explanation of this result; such as, that the filaments of cotton occupied the vacancies between the globules of water; or that, by its capillary attraction, the cotton subdivided the globules, and caused them to occupy a less space, &c.; but Mr. Trantwine, who has communicated this experiment to the *Franklin Journal,* accounts for the effect more satisfactorily, by supposing the fluid to insinuate itself between the filaments of cotton, and thus permit the latter to occupy no more space than is due to their actual solidity.

Caustic Paste of Sulphate of Copper.—A sufficient quantity of sulphate of copper is reduced to powder, and formed into a soft paste with yolk of egg. This paste is spread on a small pledget of lint, or on a piece of linen or sparadrap, of the dimensions of the point to be cauterised. At the end of three or four hours the caustic effect is produced; the shield is then removed, and there remains a scar which is not deep, and which shortly leaves but an almost imperceptible trace. This caustic is especially recommended for those parts of the skin which are habitually uncovered.

To form Artificial Haloes.—Take a saturated solution of *alum,* and having spread a few drops of it over a plate glass, it will rapidly crystallize in small, flat octohedrons, scarcely visible to the eye. When the plate is held between the observer and the sun, or a candle, with the eye very close to the smooth side of the glass-plate, there will be seen three beautiful haloes of light, at different distances from the luminous body. The innermost halo, which is the whitest, is formed by the images refracted by a pair of faces of the octohedral crystals, not much inclined to each other. The second halo, which is more colored, with the blue rays outwards, is formed by a pair of faces more inclined; and the third halo, which is very large and highly colored, is formed by a still more inclined pair of faces. Each separate crystal forms three images of the luminous body, placed at points 120° distant from each other, in all the three haloes; and as the numerous small crystals have their refracting faces turned in every possible direction, the whole circumference of the haloes will be completely filled up. The same effects may be obtained with other crystals, and when they have the property of double refraction, each halo will be either doubled, when the double refraction is considerable, or rendered broader, and otherwise modified in point of color, when the double refraction is small. The effects may be curiously varied, by crystallizing, upon the same plate of glass, crystals of a decided color, by which means we should have white and colored haloes succeeding each other.

DOMESTIC GREENHOUSES AND FERNERIES.



DOMESTIC GREEN-HOUSES AND FERNERIES.

There are few subjects in which the last few years have produced a greater change than the cultivation of plants in rooms, particularly in those situated in the dense parts of cities. A very short time back a few superannuated geraniums in pots, and two or three lanky hyacinths in glasses, were almost all that could be made to blossom in confined situations; and if the denizen of the metropolis garnished his apartment with a Clove Pink, or a Carnation—a Verbna, or a Heath, it was only a brief space that he could make them survive in such a contaminated atmosphere; as to flourishing it was out of the question—every shrub he might procure became stunted, black and flowerless. The Daisy, Violet, and Heart's-ease all died, even the hardy Stonecrop, Thrift, and House-leek, dragged on but a miserable existence. Thus discouraged, the Londoner aimed no longer to be *rus in urbe*, and sought in other things for those decorations which he hoped to have reaped from the bountiful hand of nature. Why this general disease and mortality should take place was variously explained by one party, and that by far the most numerous it was thought to arise from want of *fresh air;* by which term it was understood, air such as that of the fields uncontaminated by the breathing of animals, and not deoxydated by the burning of culinary and manufacturing fires. But said another party, plants ought to thrive better in cities because they live upon carbonic acid gas, and both respiration and combustion furnish it to them in greater abundance than in the open country.

This last opinion being theoretically true, the question arises, how is it then that they dwindle under such apparently favorable circumstances? Upon reflecting upon it we trace several causes for this effect. First, we must consider that a plant in its native place of growth, or even in a country garden, is subjected always to a seasonable and natural temperature, not thrown into unwonted vigor by too much heat, nor withered by want of moisture. In those seasons when plants grow most vigorously, namely, spring and autumn, the dews of night fill the absorbent vessels, the moderate heat of day stimulates the languid system of vegetation. These regular alterations of warmth and moisture can scarcely be imitated with convenience in domestic gardening. Here then is one cause of want of vigor. A second is to be found in the inferior and unequal degree of light. In the open country a plant is surrounded by the strongest light throughout the day—in a room, light comes perhaps only through a window and even then without clearness or brilliance; thus the stems become elongated, the leaves sickly and white, the flowers pale and scentless, the fruit abortive, although the poor deplorable plant used its best endeavours to escape to a clearer atmosphere, by growing towards the window and to obtain every particle of light it can by turning all its moveable parts in the same direction.

A third cause of failure is the contamination of the atmosphere in which the plants are placed, not from the presence of carbonic acid gas, that they could probably bear; nor yet sulphurous acid gas, as some have said, but because it is loaded with fine particles of smoke, and other exhalations which coal fires always yield in abundance; this wafted through the air when hot, settles when cold on every thing around, plants and all. By this means the pores of the leaves become clogged up, the stomatæ upon their surfaces, which are the organs of respiration, evaporation and partly of absorption, become impeded in their important functions, and the sap no longer elaborated by the leaves, ceases to deposit those secretions upon which vegetable vigor and health, we may say life, depend.

It must be evident that if we could remove these causes of decay, we should be enabled to cultivate plants with success in confined places. Our minds would, therefore, naturally consider green-houses as the proper shelter. This is partially true, but these buildings are subject to other and great vicissitudes; for example, the direct rays of the sun upon their glazed roofs concentrates the heat within, and if the windows are opened, the moisture evaporates. Thus great attention is requisite, not only to ensure a proper degree of warmth, but of moisture also—and the contamination of the atmosphere is unprovided for.

Reflecting upon these several circumstances, Mr. Ward, of Wellclose-square, one of our first botanists, suggested that if plants were placed in air-tight cases, every obstacle to their luxuriant growth would be removed, fuliginous particles would be excluded, these cases being placed in an apartment, sufficiently equable temperature will be preserved, and the moisture, with which they are at first furnished evaporating, will roll down the sides of the glass and be again taken up by the roots and passed upwards to the foliage; thus a succession takes place as in nature, without the least attention being necessary; and although this does not remedy the want of light, but rather diminishes the small quantity otherwise obtainable, yet it is only to choose such plants as grow naturally in confined situations, amid obscurity and moisture, and we are then enabled to have a flourishing garden, even in the narrowest courts of a city. The size of such a garden may be that most convenient to us, from the extent of an apartment to the confinement of a common glass bottle.

The following directions on the formation, arrangement, and management of Domestic Green-houses, and on the choice and procuring of subjects for them, will we hope be useful.

Plants have been grown in a common quart bottle, (white glass,) and are to be managed thus:—Put the plant first into the bottle, and hold it up a little, so that nothing but a part of the roots shall touch the bottom, or if there be room enough not even these. Then having some of the proper earth, in a rather dry state, pour it gradually in so as to surround the roots, and lie evenly about them. Next pour in sufficient water to saturate the earth, and this being done, cork up the bottle so as to be completely air-tight. The plant will take root and flourish for a long period without any attention whatever. It should be kept near the light.

Plants may be raised from seed in the same manner, putting in the earth first, water next, and the seed being sprinkled on the top—until the seed germinates or begins to grow, it must be placed in a dark situation.

Glass cases for growing several plants together may be made as follows.—Procure a wooden box of any convenient length and breadth, and 6 or 8 inches deep; have a groove made around the top of the

box to hold a glass shade, either made of one piece like those shades which are used to cover alabaster vases, birds, &c.; or else made of five pieces of glass joined by a strip of pasted paper, or by a brass or wooden frame-work at the edges. Place the proper earth in the wooden box, and the plants or seeds in it, water them well and put on the glass cover. The lower edge of this it will be remembered fits in a groove, made larger than the cover, so that when the latter is put on a space shall be all around it. It may either remain thus, or be filled with water or putty—rendering the case thereby air-tight.

Green-houses.—The above are adapted to keep within an apartment, as for example, withinside a parlor or study window; but it may be wished to construct a building which shall be capable of holding a much larger quantity of plants; such may be constructed exactly like a common green-house, but not capable of being opened, except by means of a door or window communicating with an apartment; thus, although not air-tight, it is defended from great and sudden alterations—not being in communication with the open air.

Greenhouses or Ferneries, as they are called from having Ferns mostly growing in them, are from their size capable of much embellishment. The plants may be arranged in pots, as in a common greenhouse—or much better, slanting shelves may be made of slate, or stone, and projecting some distance from the wall, earth is rammed behind them. Besides this are two other methods usually combined, the lower part being formed into a kind of ornamental rockwork, the upper part covered with the rough bark of trees, nailed on, and little plants stuck in every cavity capable of holding earth.

The cuts represents some of these buildings of a large size laid out in rockwork with fountain, &c. The plants seen growing in it are called FERNS, an account of which, and method of procuring some of them, requisite soil, &c., planting and after-management we propose giving in a short time.

(Continued on page 76.)

CHROMIUM AND ITS COMBINATIONS.

THE only ore of this metal which occurs in sufficient abundance for the purposes of art is the octohedral chrome-ore, commonly called the chromate of iron, though it is rather a compound of the oxides of chromium and iron. The fracture of this mineral is uneven; its lustre imperfectly metalic; its color between iron-black and brownish-black, and its streak brown. Its specific gravity in the purest state rises, to 4·5; but the usual chrome-ore found in the market varies from 3 to 4. According to Klaproth this ore consists of oxide of chromium, 43; protoxide of iron, 34·7; alumina, 20·3; and silica, 2; but Vanquelin's analysis of another specimen gave, respectively, 55·5, 34, 6, and 2. It is fusible before the blowpipe; but it acts upon the magnetic needle, after having been exposed to the reducing smoky flame. It is entirely soluble in borax at a high blowpipe heat and imparts to it a beautiful green color.

Chrome-ore is found at the Bare-Hills near Baltimore, in Maryland; in the Shetland Isles, Unst and Fetlar; the department of Var, in France, in small quantity; and near Portsoy, in Banffshire; as also in Silesia and Bohemia.

Chromate of Potass.—The chief application of this ore is to the production of chromate of potash, from which salt the various other preparations of this metal used in the arts are obtained. The ore is reduced to a fine powder by being ground in a mill under ponderous edge-wheels, and sifted. It is then mixed with one third or one half its weight of coarsely bruised nitre, and exposed to a powerful heat, for several hours, on a reverberatory hearth, where it is stirred about occasionally. In the large manufactories of this country, the ignition of the above mixture in pots is laid aside, as too operose and expensive. The calcined matter is raked out, and lixiviated with water. The bright yellow solution is then evaporated briskly, and the chromate of potash falls down in the form of a granular salt, which is lifted out from time to time from the bottom with a large ladle, perforated with small holes, and thrown into a draining box. This saline powder may be formed into regular crystals of neutral chromate of potash by solution in water and slow evaporation; or it may be converted into a more beautiful crystalline body, the bichromate of potash, by treating its concentrated solution with nitric, muriatic, sulphuric, or acetic acid, or, indeed, any acid exercising a stronger affinity for the second atom of the potash than the chromic acid does.

Bichromate of potash, by evaporation of the above solution, and slow cooling, may be obtained in the form of square tables, with bevelled edges or flat four-sided prisms. They are permanent in the air, have a metallic and bitter taste, and dissolve in about one tenth of their weight of water, at 60° F; but in one half of their weight of boiling water. They consist of chromic acid, 13; potash, 6; or in 100 parts, 68·4 + 31·6. This salt is much employed in calico-printing and dyeing.

Chrome Yellow.—The chrome yellow of the painter is a rich pigment of various shades, from deep orange to the palest canary yellow. It is made by adding a limpid solution of the neutral chromate (the above granular salt) to a solution, equally limpid, of acetate or nitrate of lead. A precipitate falls which must be well washed and carefully dried out of the reach of any sulphuretted vapours. A lighter shade of yellow is obtained by mixing some solution of alum or sulphuric acid with the chromate, before pouring it into the solution of lead; and an orange tint is to be procured by the addition of sub-acetate of lead in any desired proportion.

Chrome Green.—The green oxide of chrome has come so extensively into use as an enamel color for porcelain, that a fuller account of the best modes of manufacturing it must prove acceptable to many of our readers.

That oxide in combination with water called the hydrate may be economically prepared by boiling chromate of potash dissolved in water, with half its weight of flowers of sulphur, till the resulting green precipitate ceases to increase, which may be easily ascertained by filtering a little of the mixture. The addition of some potass accelerates the operation. This consists in combining the sulphur with the oxygen of the chromic, so as to form sulphuric acid, which unites with the potash of the cromate into sulphate of potash while the oxide becomes a hydrate. An extra quantity of potash facilitates the deoxidizement of the chromic acid by the formation of hyposulphite and sulphuret of potash, both of which have a strong attraction for oxygen. For

this purpose the clear lixivium of the chromate of potash is sufficently pure, though it should hold some alumina and silica in solution, as it generally does. The hydrate may be freed from particles of sulphur by heating dilute sulphuric acid upon it, which dissolves it; after which it may be precipitated, in the state of a carbonate, by carbonate of potash not added in excess.

Chrome-Red.—Liebig and Wohler have lately contrived a process for producing a subchromate of lead of a beautiful vermillion hue. Into saltpetre, brought to fusion in a crucible at a gentle heat, pure chrome-yellow is to be thrown by small portions at a time. A strong ebullition takes place at each addition, and the mass becomes black and continues so while it is hot. The chrome yellow is to be added till little of the saltpetre remains undecomposed, care being taken not to over-heat the crucible, lest the color of the mixture should become brown. Having allowed it to settle for a few minutes, during which the dense basic salt falls to the bottom, the fluid part consisting of chromate of potash and saltpetre, is to be poured off and it can be employed again in preparing chrome-yellow. The mass remaining in the crucible is to be washed with water, and the chrome-red being separated from the other matters it is to be dried after proper edulcoration. It is essential for the beauty of the color that the saline solution should not stand long over the red powder, because the color is thus apt to become of a dull orange hue. The fine crystalline powder subsides so quickly to the bottom after every ebullition that the above precaution may be easily observed.

Chromic Acid.—Chromic acid will probably ere long become an object of interest to the calico printer; the following is the best method of preparing it. To 100 parts of yellow chromate of potash, add 136 of nitrate of barytes, each in solution. A precipitate of the yellow chromate of barytes falls, which being washed and dried would amount to 130 parts. But while still moist it is to be dissolved in water by the intervention of a little nitric acid, and then decomposed by the addition of the requisite quantity of sulphuric acid, whereby the barytes is separated and the chromic acid remains associated with the nitric acid, from which it can be freed by evaporation to dryness. On re-dissolving the chromic acid residuum in water, filtering and evaporating to a proper degree, 50 parts of chromic acid may be obtained in crystals.

This acid may also be obtained from chromate of lime, formed by mixing chromate of potash and muriate of lime; washing the insoluble chromate of lime which precipitates, and decomposing it by the equivalent quantity of oxalic acid, or for ordinary purposes even sulphuric acid may be employed.

Chromic acid is obtained in quadrangular crystals of a deep red color; it has a very acrid and styptic taste. It reddens powerfully litmus paper. It is deliquescent in the air. When heated to redness, it emits oxygen and passes into the deutoxide. When a little of it is fused along with vitreous borax, the compound assumes an emerald green color.

As chromic acid parts with its last dose of oxygen very easily, it is capable in certain styles of calico printing of becoming a valuable substitute for chlorine, where this more powerful substance would not from peculiar circumstances be admissible. For this ingenious application the arts are indebted to that truly scientific manufacturer, M Daniel Kœchlin, of Mulhouse. He discovered that whenever chromate of potash has its acid set free by its being mixed with tartaric or oxalic acid, or a neutral vegetable substance, (starch or sugar for example), and a mineral acid, a very lively action is produced, with disengagement of heat, and of several gases. The result of this decomposition is the active re-agent, chromic acid, possessing valuable properties to the printer. Watery solutions of chromate of potash and tartaric acid being mixed an effervescence is produced which has the power of destroying vegetable colors. But this power lasts no longer than the effervescence. The mineral acids re-act upon the chromate of potash only when vegetable coloring matter, gum, starch, or a vegetable acid are present, to determine the disengagement of gas. During this curious change carbonic acid is evolved; and when it takes place in a retort, there is condensed in the receiver a colorless liquid, slightly acid, exhaling somewhat of the smell of vinegar, and containing a little empyreumatic oil. This liquid heated with the nitrates of mercury or silver reduces these metals. On these principles M. Kœchlin discharged indigo blue by passing the cloth through a solution of chromate of potash, and printing nitric acid thickened with gum upon certain spots. It is probable that the employment of chronic acid would supersede the necessity of having recourse in many cases to the more corrosive chlorine.

Chrome Blue.—The following directions have been given for the preparation of a *blue oxide* of chrome. The concentrated alkaline solution of chromate of potash is to be saturated with weak sulphuric acid, and then to every 8 lbs. is to be added 1 lb of common salt, and half-a-pound of concentrated sulphuric acid; the liquid will now acquire a green color. To be certain that the yellow color is totally destroyed, a small quantity of the liquor is to have potash added to it, and filtered; if the liquid is still yellow, a fresh portion of salt and of sulphuric acid is to be added: the fluid is then to be evaporated to dryness, re-dissolved, and filtered; the oxide of chrome is finally to be precipitated by caustic potash. It will be of a greenish-blue color, and being washed, must be collected upon a filter.

Chromate of Potash, adulteration of, to detect.—The chromate of potash has the power of combining with other salts up to a certain extent without any very sensible change in its form and appearance; and hence it has been sent into the market falsified by very considerable quantities of sulphate and muriate of potash, the presence of which has often escaped observation, to the great loss of the dyers who use it so extensively. The following test process has been devised by M. Zuber, of Mulhouse. Add a large excess of tartaric acid to the chromate in question, which will decompose it, and produce in a few minutes a beautiful amethyst color. The supernatant liquor will, if the chromate be pure, afford now no precipitate with the nitrates of barytes or silver; whence the absence of the sulphates and muriates may be inferred. We must, however, use dilute solutions of the chromate and acid, lest bitartrate of potash be precipitated, which will take place if less than 60 parts of water be employed. Nor must we test the liquid till the decomposition be complete, and till the color verge rather towards the green than the yellow. Eight parts of tartaric acid should be added to one of chromate to obtain a sure and rapid result. If

nitrate of potash (saltpetre) is the adulterating ingredient, it may be detected by throwing it on burning coals, when deflagation will ensue. The green color is a certain mark of the transformation of the chromic acid partially into the chrome oxide; which is effected equally by the sulphurous acid and sulphuretted hydrogen. Here this metallic acid is disoxygenated by the tartaric, as has been long known. The tests to be preferred are the nitrates of silver and baryta, having previously added so much nitric acid to the solution of the suspected chromate, as to prevent the precipitation of the chromate of silver or baryta. The smallest adulteration with sulphates or muriates will thus be detected.

PREPARATION OF SHEEP SKIN RUGS.

The skins with the wool on are thoroughly cleansed from all impurities and foreign matter that may adhere to them by washing in running water, and by scraping the flesh side in the usual manner by the knife. The skins are then rounded, as it is termed, by cutting off all the extraneous and ragged parts, when they are ready to be tanned; the skins are for that purpose stretched upon frames, and laid pon tressels with the flesh side of the skin upwards; an infusion of sumach in the proportion of one pound to a gallon of water is then poured over the skin, and the tanning matter is well worked into the pores of the skin by the aid of the knife. When dry, the reverse, or wool side of the skin, is next placed upwards and thoroughly washed with a strong alkaline soap and water, and afterwards in fair water, by which means the grease and filth are removed; when this is dry, the skin undergoes a second operation of tanning with the sumach as before mentioned, and after being dried, its harsh and rigid surface is rendered smooth and soft by rubbing it over with pumice stone. In order to dye it of any color, before it is taken off the frame, its face or woolly part is dipped into a bath of the required tint, prepared in the ordinary manner for dyeing wool; the washing must now again be repeated to get rid of the excess of coloring matter which adheres to it. The skins being then dried and trimmed to the proper shape are considered complete rugs, and are ready for sale.

FORMER HIGH TEMPERATURE OF EUROPE.

Vegetables appear to have formed the commencement of organic life on the earth. Their debris are the only things met with in the oldest beds deposited by water, and these belong to plants of the most simple structure,—ferns, reeds, and lycopodiums.

Vegetation becomes more and more complicated in the upper formations. Finally, near the surface, it resembles the vegetation of the present continents, but with this very remarkable addition, that certain vegetables which flourish only in the south, such as large palm-trees, are found, in a fossil state, in all latitudes, and even in the midst of the frozen soil of Siberia.

In the ancient world, these northern regions must have possessed, during winter, a temperature at least equal to that which is experienced at present in the parallels where large palm-trees begin to flourish. At Tobolsk, there was the climate of Alicant or Algiers!

We shall discover fresh proof of this mysterious result from an attentive examination of the dimensions of plants.

There are, at the present day, species of reeds, of ferns, and lycopodiums, as well in Europe as the equinoctial regions; but it is only in warm climates that they are of great dimensions. Thus, a comparison of the dimensions of the same plants is, in fact, to compare, in reference to temperature, the regions where they were produced. Place beside the fossil plants of our coal formations, not the analogous European plants, but such as abound in those regions of South America most celebrated for the richness of their vegetation, and you will find the former incomparably larger than the latter.

The *fossil floras* of France, England, Germany, and Scandinavia, exhibit, for instance, ferns nearly 50 feet high, and with branches 3 feet in diameter, or 9 feet in circumference.

The *Lycopodineæ*, which, at the present time, in cold or temperate regions, are creeping plants, scarcely rising above the surface; which, even at the equator, under the most favorable circumstances, do not rise to more than 3 feet, reached in Europe, in the ancient world, to the height of 80 feet.

One must be blind, not to see, in these enormous dimensions, a new proof of the high temperature formerly possessed by our country before the last irruptions of the ocean.

SILVERING AND TINNING.

To Silver by Heat. No. 1.—Dissolve an ounce of pure silver in aqua-fortis, and precipitate it with common salt; to which add ½ lb. of sal-ammoniac, the same of white vitriol, and ¼ oz. of corrosive sublimate.

No. 2.—Dissolve an ounce of pure silver in aqua-fortis; precipitate it with common salt, and add, after washing, 6 ounces of common salt, 3 ounces each of sandiver and white vitriol, and ¼ ounce of sublimate.

These are to be ground into a paste upon a fine stone with a muller; the substance to be silvered must be rubbed over with a sufficient quantity of the paste, and exposed to a proper degree of heat. When the silver runs, it is taken from the fire, and dipped into weak spirit of salt to clean it.

Silvering on Gilt Work, by Amalgamation.—Silver will not attach itself to any metal by amalgamation, unless it be first gilt. The process is the same as gilding in colors, only no acid should be used.

To Silver in the Cold Way.

No. I.—2 dr. tartar,
2 dr. common salt,
½ dr. of alum, and
20 grs. of silver, precipitated from the nitrous acid by copper.

Make them into a paste with a little water. This is to be rubbed on the surface to be silvered with a cork, &c.

No. 2.—Dissolve pure silver in aqua-fortis, and precipitate the silver with common salt; make this precipitate into a paste, by adding a little more salt and cream of tartar. It is applied as in the former method.

To Silver Copper Ingots.—The principal difficulties in plating copper ingots are, to bring the surfaces of the copper and silver into fusion at the

same time, and to prevent the copper from scaling; for which purposes fluxes are used. The surface of the copper on which the silver is to be fixed must be made flat by filing, and should be left rough. The silver is first annealed, and afterwards pickled in weak spirit of salt; it is planished, and then scraped on the surface to be fitted on the copper. These prepared surfaces are anointed with a solution of borax, or strewed with fine powdered borax itself, and then confined in contact with each other, by binding wire. When they are exposed to a sufficient degree of heat, the flux causes the surfaces to fuse at the same time, and after they become cold they are found firmly united.

Copper may likewise be plated by heating it, and burnishing leaf-silver upon it; so may iron and brass. This process is called FRENCH PLATING.

To separate the Silver from Plated Copper.—This process is applied to recover the silver from the plated metal, which has been rolled down for buttons, toys, &c., without destroying any large portion of the copper. For this purpose, a menstruum is composed of 3 pounds of oil of vitriol, 1½ ounce of nitre, and a pound of water. The plated metal is boiled in it, till the silver is dissolved, and then the silver is recovered by throwing common salt into the solution.

To plate Iron.—Iron may be plated by three different modes.

1st. By polishing the surface very clean and level with a burnisher; and afterwards by exposing it to a blueing heat, a leaf of silver is properly placed and carefully burnished down. This is repeated till a sufficient number of leaves is applied, to give the silver a proper body.

2nd. By the use of a solder; slips of thin solder are placed between the iron and silver, with a little flux, and secured together by binding-wire. It is then placed in a clear fire, and continued in it till the solder melts, when it is taken out, and on cooling is found to adhere firmly.

And 3rdly. By tinning the iron first, and uniting the silver by the intermedia of slips of rolled tin, brought into fusion in a gentle heat.

To tin Copper and Brass.—Boil six pounds of cream of tartar, four gallons of water, and eight pounds of grain tin, or tin shavings. After the materials have boiled a sufficient time, the substance to be tinned is put therein, and the boiling continued, when the tin is precipitated in its metallic form.

To tin Iron and Copper Vessels.—Iron which is to be tinned must be previously steeped in acid materials, such as sour whey, distiller's wash, &c.; then scoured and dipped in melted tin, having been first rubbed over with a solution of sal-ammoniac. The surface of the tin is prevented from calcining, by covering it with a coat of fat. Copper vessels must be well cleansed; and then a sufficient quantity of tin with sal-ammoniac is put therein, and brought into fusion, and the copper vessel moved about. A little resin is sometimes added. The sal-ammoniac prevents the copper from scaling, and causes the tin to be fixed wherever it touches. Lately, zinc has been proposed for lining vessels instead of tin, to avoid the ill consequences which have been unjustly apprehended.

ENGRAVING ON GLASS.

THIS is an amusing and sometimes a useful experiment, and as involving also a little serviceable practical manipulation, is worthy of description. Suppose the object be to engrave a design on a piece of flat glass; common crown glass will be found the best for the purpose, and a pane of this substance should be procured of such dimensions that a circle may be described upon it large enough to include the intended drawing. The glass is then to be warmed over a spirit-lamp, sand-bath, or other convenient source of heat, and rubbed with yellow bees'-wax; this will melt and by using such a quantity of it as will flow readily upon the glass when hot, a uniform coat may be applied. If when cold it prove to be not quite uniform, still if every part of the surface to be engraved be perfectly covered, it will suffice. The design is then to be traced upon the waxed side with a coarse point, every mark being made to penetrate the wax. The point may be that of a needle, or a piece of wire, or a brad-awl; if made flat at the end in one direction, but round in another, so as to resemble a minute round-edged chisel no difficulty will be found in making lines through the wax, finer or coarser, according to the relative position of the edge or end of the tool and the line which it is describing. If the design be previously drawn upon paper with ink, it may be easily seen and traced through the wax.

An evaporating basin, either of earthenware or metal, is to be selected of a diameter that will include the whole of the design when the glass plate is inverted over its mouth. Coarsely bruised fluor spar, in quantity equal to about two ounces for a pint bason, is to be put into the bason with a sufficient quantity of strong oil of vitriol to make it into a thin paste; the two substances are to be stirred together with a wire, and the waxed plate put over the mouth of the basin, with the design downwards. A moderate heat is then to be applied to the bottom of the basin, which is best done by means of the sand-bath; it soon causes the evolution of fumes in abundance from the mixture, but should never be allowed to increase so as to melt the wax on any part of the glass; a temperature of 140° or 160° is sufficient. The basin and its contents, being warmed, should be removed to a cooler part of the sand-bath, and left for half an hour. The etching is known to proceed well when, upon raising one edge of the plate, vapors are visible within. At the end of the half hour the glass plate should be rinsed with water to wash off the adhering acid, and the wax removed either by scraping it with the edge of a flat case knife, or otherwise. The design will generally be found perfectly engraved upon the glass and may be rendered still more evident by lightly rubbing over it a little finely powdered vermillion with a ball of cotton.

If the glass to be etched or engraved be so formed as not to close the mouth of a basin or capsule, it must be waxed all over, which may be done by dipping it into the melted substance; and after the design is drawn upon it, it must be put with the mixture of fluor spar and sulphuric acid into a vessel sufficiently long and deep to include the whole of the glass to be etched. The mixture of fluor spar and sulphuric acid is to be placed at the bottom, and the glass supported over it upon corks or wires, or suspended so as to be out of contact with the mixture. The vessel is then to be covered over, that the vapor which rises may be retained and surround the glass on every side. Evaporating basins,

metallic dishes, or other metallic vessels, not having sufficient depth, may be made to answer the purpose by a paper cap or cone put over the edge very tightly: the upper part of such a cone serves the purpose of a chamber for the reception of the glass to be engraved, and the vapors that are to act upon it.

NATIVE OIL OF LAUREL.

An account of this extraordinary vegetable production, a knowledge of which has been almost exclusively confined to the inhabitants of Spanish Guiana, was drawn up by C. S. Parker, Esq., of Glasgow, upon a late visit to Demerara by that gentleman, assisted by Dr. Hancock, a physician of that colony; from which we make the following extracts:—

"This substance, which has very injudiciously been termed Azeytoyde Sassafras, (an appellation which tends to confound it with the essential oil yielded by the Laurus Sassafras, of the northern continent of America) affords, so far as my knowledge extends, a solitary instance of a perfect volatile liquid without the aid of art. Substituting for the appellation to which I have objected the provisional name of the *Native Oil of Laurel*, I shall describe the method of procuring it, and enumerate its principal chemical and medicinal properties, as far as these have been investigated and examined.

"The Native Oil is yielded by a tree of considerable height; its wood is aromatic, compact in its texture, and of a brownish color, and its roots abound with essential oil.

"This tree which is found in the vast forests that cover the flat and fertile regions between the Oronooko and the Parime, has, from an analogy already alluded to, being supposed to belong to the natural order *Laurineæ*; and though Humboldt and Bonpland do not seem to have been acquainted with its singular and important produce, its botanical characters may very possibly have been described in their *Nova Genera et Species Plantarum Americæ Septentrionalis*, under the genera Ocotea, Persea, or Litsea.

"The Native Oil of Laurel is procured by striking with an axe the proper vessels in the internal layers of the bark; while a calabash is held to receive the fluid, which gushes out in such abundance that several quarts may be caught from a single incision if the operation be performed with dexterity. So obscure, however, are the indications of these reservoirs, that the Indians (with perhaps a little of their usual exaggeration) assert, that a person unacquainted with the art may hew down a hundred trees without collecting a drop of the precious fluid. In many of its properties the Native Oil resembles the essential oil obtained by expression, distillation, and other artificial processes: it is, however, more volatile and highly rectified than any of them, its specific gravity hardly exceeding that of alcohol. When pure it is colorless and transparent; its taste is warm and pungent; its odour aromatic, and closely allied to that of the oily and resinous juice of the conifera. It is volatile, and evaporates without residuum at the ordinary atmospheric temperature. It is inflammable, and, except when mixed with alcohol, gives out in its combustion a dense smoke. Neither the acids nor the alkalies seem to exert any sensible action upon the Native Oil: when combined, however, with sulphuric acid, the oil assumes a momentary brownish tinge, but soon regains its transparency The Oil of Laurel dissolves camphor, caoutchouc, wax and resins; and readily combines with volatile and fixed oils. It is insoluble in water; soluble in alcohol and ether. Though the specific gravity of the oil greatly exceeds that of ether, the compound formed by combining them in the proportion of one part of the former to two of the latter, floats upon the surface of pure ether, and may therefore be the lightest of all known fluids.

"With respect to the medicinal properties of the Native Oil, it bears, when externally applied, the character of a powerful discutient, and appears, when exhibited internally, to be diuretic, biuretic, and resolvant: by many it is believed to be analeptic, alternative, and anodyne; and to promote the exfoliation of carious bones.

Its efficacy has been demonstrated in rheumatism, and in various disorders supposed to originate in a vitiated state of the blood: and the employment of it externally has likewise been attended with the happiest effects in paralytic disorders; also in rheumatic headache, sprains, and bruises. To the chemist and the vegetable physiologist in particular, the Native Oil of Laurel elaborated by the unassisted hand of nature, in a state of purity which the operose processes of art may equal but cannot surpass, presents an interesting subject of inquiry, and a wide field of speculation."

DYEING WOOD FOR VENEERS, &c.

Dyeing wood is mostly applied for the purpose of veneers, while staining is more generally had recourse to, to give the desired color to the article after it has been manufactured.—In the one case, the color should penetrate throughout; while in the latter, the surface is all that is essential.

In dyeing; pear-tree, holly, and beech, take the best black; but for most colors holly is preferable.—It is also best to have your wood as young and as newly cut as possible: After your veneers are cut they should be allowed to lie in a trough of water for four or five days before you put them into the copper: as the water, acting as a purgative to the wood, brings out abundance of slimy matter; which if not thus removed, the wood will never be of a good color; after this purificatory process, they should be dried in the open air for at least twelve hours: they are then ready for the copper. By these simple means, the color will strike much quicker, and be of a brighter hue. It would also add to the improvement of the color, if, after your veneers have boiled a few hours, they are taken out, dried in the air, and again immersed in the coloring copper. Always dry veneers in the open air; for fire invariably injures the colors.

Fine Black.—Put six pounds of chip logwood into your copper, with as many veneers as it will conveniently hold, without pressing too tight; fill it with water, and let it boil *slowly* for about three hours; then add half a pound of powdered verdigris, half a pound of copperas, and four ounces of bruised nut-galls; fill the copper up with vinegar as the water evaporates; let it boil gently two hours each day, till the wood is dyed through.

Another Method.—Procure some liquor from a tanner's pit, or make a strong decoction of oak-bark, and to every gallon of the liquor add a quarter of a pound of green copperas, and mix them well together; put the liquor into the copper,

and make it quite hot, but not to boil—immerse the veneers in it, and let them remain for an hour; take them out, and expose them to the air till it has penetrated its substance; then add some logwood to the solution, place your veneers again in it, and let it simmer for two or three hours; let the whole cool gradually, dry your veneers in the shade, and they will have acquired a very fine black.

Fine Blue.—Into a clean glass bottle, put 1 lb. of oil of vitriol, and 4 ounces of the best indigo pounded in a mortar (take care to set the bottle in a basin or earthen glazed pan, as it will ferment); now put your veneers into a copper, or stone trough, fill it rather more than one-third with water, and add as much of the vitriol and indigo (stirring it about) as will make a fine blue, which you may know by trying it with a piece of white paper or wood; let the veneers remain till the dye has struck through.

The color will be much improved, if the solution of indigo in vitriol be kept a few weeks before using it; you will also find the color strike better if you boil your veneers in plain water till completely soaked through, and let them remain for a few hours to dry partially, previous to immersing them in the dye.

Another.—Throw pieces of quick lime into soft water; stir it well; when settled, strain or pour off the clear part, then to every gallon add ten or twelve ounces of the best turnsole; put the whole into your copper with your veneers, which should be of white holly, and prepared as usual by boiling in water; let them simmer gently till the color has sufficiently penetrated, but be careful not to let them boil in it, as it would injnre the color.

A Fine Yellow.—Reduce four pounds of the root of barberry, by sawing, to dust, which put in a copper or brass trough; add four ounces of turmeric, and four gallons of water, then put in as many white holly veneers as the liquor will cover; boil them together for three hours, often turning them; when cool, add two ounces of aqua-fortis, and the dye will strike through much sooner.

A Bright Yellow.—To every gallon of water, necessary to cover your veneers, add one pound of French berries; boil the veneers till the color has penetrated through; add the following liquid to the infusion of the French berries, and let veneers remain for two or three hours, and the color will be very bright.

Liquid for Brightening and Setting Colors.—To every pint of strong aqua-fortis, add one ounce of grain tin, and a piece of sal-ammoniac of the size of a walnut; set it by to dissolve, shake the bottle round with the cork out, from time to time: in the course of two or three days it will be fit for use. This will be found an admirable liquid to add to any color, as it not only brightens it, but renders it less likely to fade from exposure to the air.

Bright Green.—Proceed as in either of the above receipts to produce a yellow; but instead of adding aqua-fortis or the brightening liquid, add as much sulphate of indigo as will produce the desired color.

Another Green.—Dissolve four ounces of the best verdigris, and sap green and indigo half an ounce each, in three pints of the best vinegar; put in your veneers, and gently boil till the color has penetrated sufficiently.

The hue of the green may be varied by altering the proportion of the ingredients; and we should advise, unless wanted for a particular purpose, to leave out the sap green, as it is a vegetable color very apt to change, or turn brown, when exposed to the air.

Bright Red.—To two pounds of genuine Brazil dust, add four gallons of water; put in as many veneers as the liquor will cover; boil them for three hours; then add two ounces of alum, and two ounces of aqua-fortis, and keep it lukewarm until it has struck through.

Another Red.—To every pound of logwood chips, add two gallons of water; put in your veneers, and boil as in the last; then add a sufficient quantity of the brightening liquid till you see the color to your mind; keep the whole as warm as you can bear your finger in it, till the color has sufficiently penetrated.

The logwood chips should be picked from all foreign substances, with which it generally abounds, as bark, dirt, &c., and it is always best when fresh cut, which may be known by its appearing of a bright red color; for if stale it will look brown, and not yield so much coloring matter.

Purple.—To two pounds of chip logwood and half a pound of Brazil dust, add four gallons of water, and after putting in your veneers, boil them for at least three hours; then add six ounces of pearl-ash and two ounces of alum; let them boil for two or three hours every day, till the color has struck through.

The Brazil dust only contributes to make the purple of a more red cast; you may therefore omit it, if your require a deep bluish purple.

Another Purple.—Boil two pounds of logwood, either in chips or powder, in four gallons of water with your veneers; after boiling till the color is well struck in, add by degrees sulphate of indigo, till the purple is of the shade required, which may be known by trying it with a piece of paper; let it then boil for one hour, and keep the liquid in a milk-warm state till the color has penetrated the veneer. This method, when properly managed, will produce a brilliant purple, not so likely to fade as the foregoing.

Orange.—Let the veneers be dyed, by either of the methods previously given, of a fine deep yellow, and while they are still wet and saturated with the dye, transfer them to the bright red dye till the color penetrates equally throughout.

Silver Grey.—Expose to the weather in a cast-iron pot of six or eight gallons, old iron nails, hoops, &c., till covered with rust; add one gallon of vinegar, and two of water, boil all well for an hour; have your veneers ready, which must be air-wood (not too dry,) put them in the copper you use to dye black, and pour the iron liquor over them; add one pound of chip logwood, and two ounces of bruised nut-galls; then boil up another pot of the iron liquor to supply the copper with, keeping the veneers covered, and boiling two hours a day, till of the required color.

Another Grey.—Expose any quantity of old iron, or what is better, the borings of gun barrels, &c., in any convenient vessel, and from time to time, sprinkle them with spirits of salt, (muriatic acid,) diluted in four times its quantity of water, till they are very thickly covered with rust; then to every six pounds add a gallon of water, in which has been dissolved two ounces of salt of tartar; lay your veneers in the copper, and cover them with this liquid; let it boil for two or three hours till well soaked, then to every gallon of liquor add a quarter of a pound of green copperas, and keep the whole at a moderate temperature till the dye has sufficiently penetrated.

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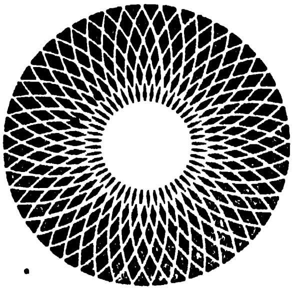

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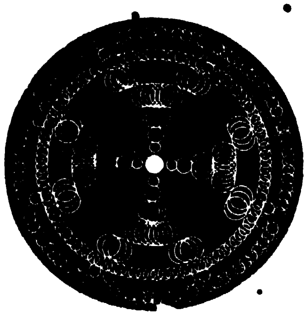

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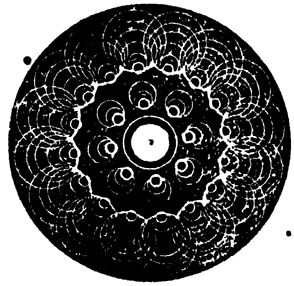

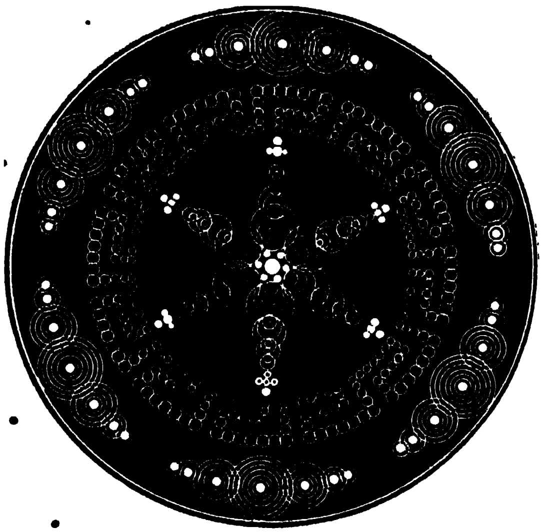

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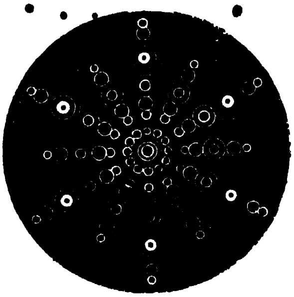

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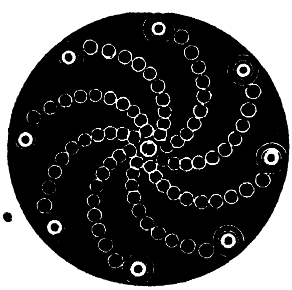

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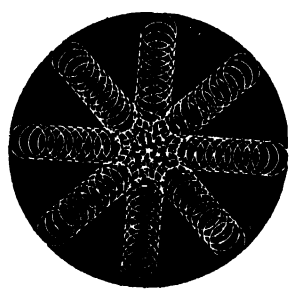
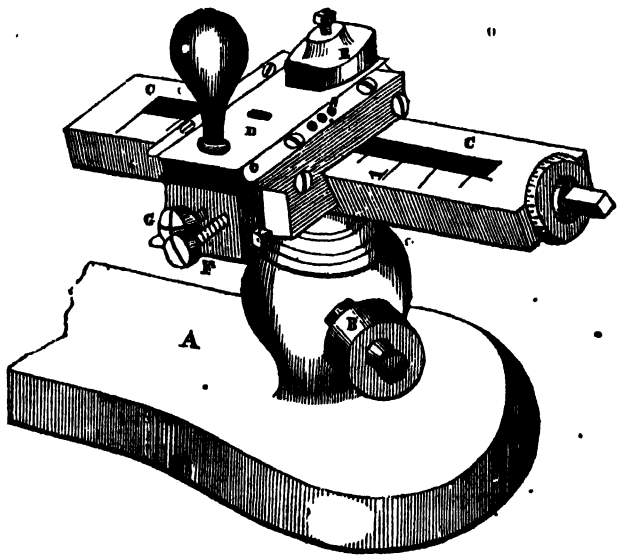


ECCENTRIC TURNING.—SLIDE REST, &c.



It was observed in page 11, when describing the Eccentric Chuck, that a peculiar slide rest was a necessary appendage to it, and also a promise was given of instructions to conduct the usual eccentric work; the object of the present paper is to fulfil that promise.

Slide Rest.—The figure in the present page represents the small slide rest. A is a bed or foot, which screws down in the usual manner to the bed of the lathe, and differs in no respect whatever from that which holds the ordinary rest; in like manner it is furnished with a screw, B, which tightens the upper part, which has a plug and fits into a socket in the upper part of A, as usual.

C C is a piece of steel, 4 or 5 inches long, of the shape represented, with a groove along the middle of it, and graduated on one side in inches and tenths of an inch; the groove should be of the same length as the height of the nose of the mandril above the bed of the lathe; the whole should be nearly half an inch in thickness, and ground perfectly true upon the face and sides, as the part D must slide accurately and smoothly backwards and forwards upon it. This part is moved by means of a screw at the end of C, which screw passes along the groove quite to the farther end, where it fits into a collar, so that when turned round by its square head, it moves D backwards and forwards, without changing its own original position. The letter D is supposed to represent the whole part of the machine which slides upon C C, and which, in like manner with C, is made of steel; it is furnished below with a screw, which fits the screw belonging to C, and on the upper part with two side pieces forming a groove in which the tool slider moves. Accuracy of grinding is here as necessary as in the former instance, as without equability of motion, eccentric turning cannot be accomplished with any certainty or beauty.

The tool-slider D has fastened near one end a brass socket, E, with a square hole quite through it horizontally and straight with its axis. This is the part where the tool fits, and which is fastened down by a screw at top. The handle is for the purpose of drawing the tool from or to the work supposed to be fixed to the mandril of the lathe opposite the end of E.

It is requisite that this part should be confined in its action at pleasure, otherwise had the tool no limit but the steadiness of the hand upon the handle, it would cut sometimes more deeply than at others, and all regularity would be destroyed; for the accomplishment of this, the screws F, G, H, are placed at the opposite end, as afterwards explained.

Tools.—The tools are formed of pieces of steel, about 2 inches long and a little more than one-eighth of an inch in thickness, the points of them being ground to certain angles, and of various shapes according to the particular kind of ornament for which they are intended. In whatever examples of eccentric turning are to be printed from, it is necessary that the ornaments should be upon a perfectly flat surface, and consist merely of a series of lines, such as in all the present illustrations, yet this is but the commoner kind of work; as the most beautiful combination of well selected ornaments, beadings, grooves, and lines of various depths and of different sizes may be made as truly and worked as easily as these.

Adjustment.—First, screw the eccentric chuck upon the mandril, and also a common cement chuck; upon this * fasten the piece of box-wood or other material to be operated upon. Turn down the surface of the work until it is precisely smooth and even, that is neither hollow nor projecting in the middle, and it will be ready for eccentric ornaments to be placed upon it. Then put a double angular tool (that is one shaped like the nib of a pen) in the socket at E, and fix it there firmly by the screw at top, and put the tool-slider in its place. Fasten the bed of the rest, A, to the bed of the lathe by its usual screw, at such a distance from the work, as for the point of the tool nearly to touch it.—

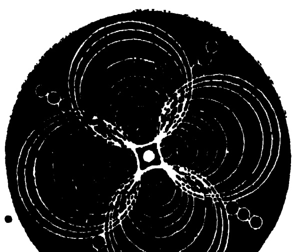
* In these directions it is supposed that our object is to form a fac-simile of some one of the present illustrations, or at any rate, some specimen of surface turning, therefore the cement chuck is mentioned; applications of the same principles, with different chucks according to circumstances, will readily suggest themselves to the turner with each particular design.

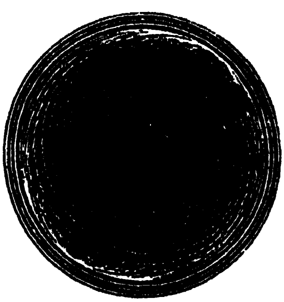
Next, by the adjustment of a T square, set the part C C, exactly parallel to the face of the work, and at such a height as for the point of the tool to be in the same line as the centre of that work—fix it in this position by the screw B. The next adjustment is to regulate the depth of the lines to be cut. The point of the tool nearly touching the work, let the screw F be moved forwards until it bears upon the end of the tool-slider frame; keep the tool up to the work by means of the handle, gradually loosening the screw F, until the line which the tool will cut is of sufficient depth; when this is the case screw up G, until that also touches the end of the tool-slider frame, that is the transverse slider, and fix it in this position by turning the nut at H; thus keeping the tool up to the work at every circle until G touches the slider, all the lines cut will be uniform in depth and width. Should it be requisite to cut them very deep, or the material operated upon be very hard, they may be cut gradually by the proper employment of the screw F, otherwise F is no longer useful, nor any other adjustment of the tool for any part of the work necessary, unless a different depth of line be required. The formation of the present and foregoing examples will be easily understood by a remembrance of the powers of the eccentric chuck formerly described, and the following directions, in which we are obliged to refer equally to the present and former paper.

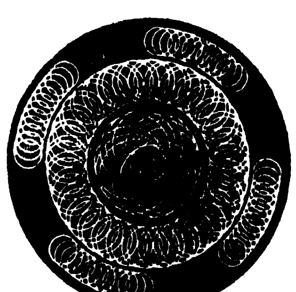
Ex. 1. (present paper)—Set the tool to cut a line of the requisite depth, and turn the screw at the end of C (slide rest), until the transverse slider has passed over one inch; this of course will cut a circle 2 inches in diameter; turn the screw at the end of the eccentric chuck four times round, and putting the mandril in motion cut a circle, or the inner part of one, that being all that is necessary at present. Keeping to all these adjustments, turn the wheel of the chuck two teeth and cut a second circle; turn it two teeth more, and cut a third circle, and so on till the whole 48 are in like manner cut, and the work is complete, except cutting it around the edges of the proper size, and cutting the hole in the middle; these must be done by restoring the chuck to its first position, when it will be without eccentricity; the size of the outer and inner rim being made by the slide rest.

Ex. 2.—Set the tool exactly opposite the centre, and so projected as to cut a deep hole in the centre; then set the tool to cut a shallow line. Alter the eccentricity (that is, turn the chuck screw half a turn), also alter the distance (that is, turn the screw of the rest) half a turn from its central position, and it will cut a small circle; turn the wheel (always understanding the cogged wheel of the chuck) 24 teeth and cut a second circle, then another 24 teeth and cut a third circle, and finally 24 teeth more, and then a fourth circle. The next row of four is made in the same manner, altering the eccentricity and distance, each another half turn of the respective screws. The third row requires another half turn each. The number of circles is made by using the numbers on the wheel as before, and also one tooth of each side of them making a group of 3. In the next row the circles are in groups of 7, or 3 on each side of the central one. In the next the groups are in threes. In the next the tool is turned back again one turn, the eccentricity increased, and every tooth of the wheel used, forming a ring of 96 circles; so on for the rest.

The other illustrations will be readily understood; it is only requisite to remember that the depth of the lines, and the size of the circles depends upon the slide rest, and their eccentricity, number and grouping, in all instances, arise from the adjustments of the chuck itself, whose combinations are endless.







COLORS OF STEAM AND OF THE ATMOSPHERE.

Professor Forbes has read to the Royal Society of Edinburgh two communications, of which the following are abstracts:—

The author incidentally remarked, that the color of the sun seen through vapour issuing from the safety-valve of a locomotive engine is deep red, exactly similar to that which a column of smoke or smoked glass gives to it.

He next noticed that this colorific character of steam extended but a short way beyond the orifice, and that it gradually became more opaque, and perfectly white, like noon-day clouds, both for transmitted and reflected light. At a moderate thickness, in this state, its opacity is complete.

These observations have been fully confirmed by direct experiments on high-pressure steam. At the moment of issuing from the steam-cock, it is perfectly transparent and colorless; at some distance from the orifice, it becomes transparent and orange-red; but still farther off it is white, and merely translucent. These properties were traced in steam from a pressure above that of the atmosphere of 55 lbs., down to an excess of only three or four; and,

as in all cases the redness of the transmitted light was more or less distinctly seen, (and an excess of 10 or 15 lbs. does as well as any higher pressure), it was concluded that the effect of partial condensation in producing the phenomenon would be rendered visible in great thickness of vapour of the lowest tension.

The great analogy of the color of steam to that which the clouds assume at sun-set, or distant lights in certain conditions of the atmosphere, led the author to suggest this singular property of condensing vapour as the probable cause of those phenomena, of which no satisfactory explanation could be given whilst this fact remained unknown. The prognostics of weather derived from the colors of the sky also receive elucidation from the fact.

Judging from the similarity of the color of steam and that of nitrous acid gas, and the remarkable power of absorbing certain definite rays of the spectrum discovered in that gas by Sir David Brewster, the author thought it probable that similar lines might be discovered in the spectrum formed by light transmitted through steam; and that these might be found to coincide with the *atmospheric lines* of the spectrum noticed by the same philosopher. The experiment was made with great care, but the expected result has not been hitherto obtained. The general action of steam on the spectrum is to absorb the violet, blue, and yellow rays, finally, leaving only the red and orange, with an imperfect green.

Since a portion of watery vapour in a confined space, originally transparent and colorless, may become, by mere change of temperature, first deep orange-red and transparent, and, finally, white and semi-opaque—the author notices another analogy with the singular effect of temperature in deepening the color of nitrous acid gas, and thinks that these facts may one day throw some farther light on the difficult subject of the mechanical constitution of vapours, and particularly of clouds.

The object of the second communication was to develop an application of the above fact. The discovery that steam in a certain stage of condensation is deeply red colored for transmitted light, seemed to offer a probable solution of a difficulty which has never yet been fairly met, namely, the red color of clouds at sun-set, and the redness of light transmitted through certain kinds of fogs.

A pretty full history of theories proposed to account for the colors of the atmosphere was first given; it being obtained almost in every case from an examination of the original authorities. These theories were reduced under three general heads, exclusive of that of Goethe, and of most writers before Newton, that the blue color of the sky results from a mixture of light and shade; and that of Muncke, that the color is merely *subjective*, or arises from an occular deception. The remaining theories are :—

1. That the color of the sky is thus transmitted by pure air, and that all the tints it displays are modifications of the reflected and transmitted colors. This is more or less completely the opinion of Mariotte, Bouguer, Euler, Leslie, and Brandes.

2. That the colors of the sky are explicable by floating vapours acting as thin plates do, in reflecting and transmitting complementary colors. This is the theory of Newton and most of his immediate followers, and more lately of Nobili.

3. On the principle of opalescence and of specific absorption, depending on the nature and unknown constitution of floating particles. This head is intended to embrace the various opinions of Melvill, Delaval, Count Maistre, and Sir D. Brewster.

To the last named philosopher, however, the merit is due of having conspicuously turned attention to the important, complex, and hitherto unexplained phenomena of absorption, which he has proved to be totally inconsistent with Newton's theory of the colors of nature, (considered as those of thin plates;) and he has farther demonstrated the inapplicability of it in the case of the colors of the atmosphere, by showing that their constitution is wholly distinct from that which any modification of Newton's theory would assign, by a series of experiments, of which as yet the results only are announced.

Since, then, the constitution of the atmospheric colors analysed by the prism resembles that produced by absorption, the question is, to what medium are we to refer that absorptive action? Evidently not to pure air, since a distant light is red in a fog, and in clear weather white, or nearly so. The author is disposed to attribute the effect to the presence of vapour in the very act of condensation. This intermediate or colorific stage occurs between the colorless and transparent form of steam wholly uncondensed, and that which may be termed the state of *proximate* condensation in which it is seen to issue from the spout of a kettle when it is likewise colorless, but semi-opaque. During the transition, the steam becomes intensely red, and remains transparent. The absorptive action resembles then, so far, that of the atmosphere observed under certain meteorological conditions; the dark lines and bands noticed by Sir David Brewster in the atmospheric spectra have not been discovered, and so far the analogy is as yet imperfect.

In applying this theory to the colors of sunset in particular, the author quotes many acknowleged facts to prove that the redness of the sky is developed precisely in proportion to the probable existence of vapour, in that critical stage of condensation which should render it colorific. And he applies the same reasoning to account for the prognostics of weather drawn from the redness of the evening and morning sky.

SILKWORMS,

THEIR LIFE, PRODUCE, AND MANAGEMENT.

The silkworm, called by entomologists *Phalæna bombyx mori*, is, like its kindred species, subject to four metamorphoses. The egg, fostered by the genial warmth of spring, sends forth a caterpillar, which, in its progressive enlargement, casts its skin either three or four times, according to the variety of the insect. Having acquired its full size in the course of 25 or 30 days, and ceasing to eat during the remainder of its life, it begins to discharge a viscid secretion, in the form of pulpy twin filaments, from its nose, which harden in the air. These threads are instinctively coiled in an ovoid nest round itself, called a cocoon, which serves as a defence against living enemies and changes of temperature. Here it soon changes into the chrysalis or nymph state, in which it lies swaddled, as it were, for about 15 or 20 days. Then it bursts its cere ments, and comes forth furnished with appropriate wings, attennæ, and feet, for living in its new element, the atmosphere. The male and the female moths couple together at this time, and terminate

their union by a speedy death, their whole existence being limited to two months. The cocoons are completely formed in the course of three or four days, the finest being reserved as seed-worms. From these cocoons, after an interval of 18 or 20 days, the moth makes its appearance, perforating its tomb by knocking with its head against one end of the cocoon, after softening it with saliva, and thus rendering the filaments more easily torn asunder by its claws. Such moths or aurelias are collected and placed upon a piece of soft cloth, where they couple and lay their eggs.

The eggs, or grains, as they are usually termed, are enveloped in a liquid which causes them to adhere to the piece of cloth or paper on which the female lays them. From this glue they are readily freed, by dipping them in cold water and wiping them dry. They are best preserved in the *ovum* state at a temperature of about 55° F. If the heat of spring advances rapidly in April, it must not be suffered to act on the eggs, otherwise it might hatch the caterpillars long before the mulberry has sent forth its leaves to nourish them. Another reason for keeping back their incubation is, that they may be hatched together in large broods, and not by small numbers in succession. The eggs are made up into small packets of an ounce, or somewhat more, which in the south of France are generally attached to the girdles of the women during the day, and placed under their pillows at night. They are, of course, carefully examined from time to time. In large establishments they are placed in an appropriate stove-room, where they are exposed to a temperature gradually increased till it reaches the 86th degree of Fahrenheit's scale, which term it must not exceed. Aided by this heat, Nature completes her mysterious work of incubation in eight or ten days. The teeming eggs are now covered with a sheet of paper pierced with numerous holes, about one-twelfth of an inch in diameter. Through these apertures the new-hatched worms creep upwards instinctively, to get at the tender mulberry leaves strewed over the paper.

The nursery where the worms are reared, is called by the French a *magnaniere;* it ought to be a well-aired chamber, free from damp, excess of cold or heat, rats, and other vermin. It should be ventilated occasionally, to purify the atmosphere from the noisome emanations produced by the excrements of the caterpillars and the decayed leaves. The scaffolding of the wicker-work shelves should be substantial, and they should be from 15 to 18 inches apart. A separate small apartment should be allotted to the sickly worms. Immediately before each moulting the appetite of the worms begins to flag; it ceases altogether at that period of cutaneous metamorphosis, but revives speedily after the skin is fairly cast, because the internal parts of the animal are thereby allowed freely to develop themselves. At the end of the second age, the worms are half an inch long, and should then be transferred from the small room in which they were first hatched, into the proper apartment where they are to be brought to maturity and set to spin their balls. On occasion of changing their abode, they must be well cleansed from the litter, laid upon beds of fresh leaves, and supplied with an abundance of food every six hours in succession. In shifting their bed, a piece of net-work being laid over the wicker plates, and covered with leaves, the worms will creep up over them, when they may be transferred in a body upon the net. The litter, as well as the sickly worms, may thus be readily removed without handling a single healthy one. After the third age they may be fed with entire leaves, because they are now exceedingly voracious, and must not be subsequently stinted in their diet. The exposure of chloride of lime, spread thin upon plates, to the air of the *magnaniere*, has been found useful in counteracting the tendency which sometimes appears of an epidemic disease among the silkworms, from the fetid exhalations of the dead and dying.

When they have ceased to eat, either in the fourth or fifth age, agreeable to the variety of the *bombyx*, and when they display the spinning instinct by crawling up among the sprigs of heath, &c., they are not long in beginning to construct their cocoons, by throwing the thread in different directions, so as to form the floss, filoselle, or outer open network, which constitutes the *bourre*, or silk, for carding and spinning.

The cocoons destined for filature, must not be allowed to remain for many days with the worms alive within them; for should the chrysalis have leisure to grow mature or come out, the filaments at one end would be cut through, and thus lose almost all their value. It is therefore necessary to extinguish the life of the animal by heat, which is done either by exposing the cocoons for a few days to sunshine, by placing them in a hot oven, or in the steam of boiling water. A heat of 202° F. is sufficient for effecting this purpose, and it may be best administered by plunging tin cases filled with the cocoons into water heated to that pitch.

Eighty pounds French (88 Eng.) of cocoons are the average produce from one ounce of eggs, or 100 from one ounce and a quarter; but M. Folzer of Alsace obtained no less than 165 pounds. The silk obtained from a cocoon is from 750 to 1150 feet long. The varnish by which the coils are glued slightly together, is soluble in warm water.

The silk husbandry, as it may be called, is completed in France within six weeks from the end of April, and thus affords the most rapid of agricultural returns, requiring merely the advance of a little capital for the purchase of the leaf. In buying up cocoons, and in the filature, indeed, capital may be often laid out to great advantage. The most hazardous period in the process of breeding the worms is at the third and fourth moulting; for upon the sixth day of the third age, and the seventh day of the fourth, they in general eat nothing at all. On the first day of the fourth age, the worms proceeding from one ounce of eggs will, according to Bonafons, consume upon an average 23 lbs. and a quarter of mulberry leaves; on the first of the fifth age, they will consume 42 lbs.; and on the sixth day of the same age, they acquire their maximum voracity, devouring no less than 223 lbs. From this date their appetite continually decreases, till on the tenth day of this age they consume only 56 lbs. The space which they occupy upon the wicker tables, being at their birth only nine feet square, becomes eventually 239 feet. In general, the more food they consume, the more silk they will produce.

A mulberry-tree is valued, in Provence, at from 6d. to 10d.; it is planted out of the nursery at four years of age; it is begun to be stripped in the fifth year, and affords an increasing crop of leaves till the twentieth. It yields from 1 cwt. to 30 cwt. of leaves, according to its magnitude and mode of cultivation. One ounce of silkworm eggs is worth in France about 2½ francs; it requires for its due

development into cocoons about 15 cwt. of mulberry leaves, which cost upon an average 3 francs per cwt. in a favorable season. One ounce of eggs is calculated to produce from 80 to 100 lbs. of cocoons, of the value of 1 franc 52 centimes per lb., or 125 francs in the whole. About 8 lbs. of reeled raw silk, worth 18 francs a lb., are obtained from these 100 lbs. of cocoons.

There are three denominations of raw silk; viz., organzine, *trame* (shute or tram), and floss. Organzine serves for the warp of the best silk stuffs, and is considerably twisted; tram is made usually from inferior silk, and is very slightly twisted, in order that it may spread more, and cover better in the weft; floss, or *bourre*, consists of the shorter broken silk, which is carded and spun like cotton. Organzine and trame may contain from 3 to 30 twin filaments of the worm; the former possesses a double twist, the component filaments being first twisted in one direction, and the compound thread in the opposite; the latter receives merely a slender single twist. Each twin filament gradually diminishes in thickness and strength, from the surface of the cocoon, where the animal begins its work in a state of vigour, to the centre, where it finishes it in a state of debility and exhaustion; because it can receive no food from the moment of its beginning to spin by spouting forth its silky substance. The winder is attentive to this progressive attenuation, and introduces the commencement of some cocoons to compensate for the termination of others. The quality of raw silk depends, therefore, very much upon the skill and care bestowed upon its filature. The softest and purest water should be used in the cocoon kettle.

The quality of the raw silk is determined by first winding off 400 ells of it, round a drum one ell in circumference, and then weighing that length. The weight is expressed in grains, 24 of which constitute one denier; 24 deniers constitute one ounce; and 16 ounces make one pound. This is the Lyons rule for valuing silk. The weight of a thread of raw silk 400 ells long, is two grains and a half, when five twin filaments have been reeled and associated together.

Raw silk is so absorbent of moisture, that it may be increased ten per cent. in weight by this means. This property has led to falsifications, which are detected by inclosing weighed portions of the suspected silk in a wire-cloth cage, and exposing it to a stove-heat of about 78° F. for 24 hours, with a current of air. The loss of weight which it thereby undergoes, demonstrates the amount of the fraud. There is in Lyons an office called the *Condition*, where this assay is made, and by the report of which the silk is bought and sold. The law of France requires, that all the silk tried by the *Condition* must be worked up into fabrics in that country.

In the Journal of the Asiatic Society of Bengal for January 1837, there are two very valuable papers upon silkworms; the first, upon those of Assam, by Mr. Thomas Hugon, stationed at Nowgong; the second by Dr. Helfer, upon those which are indigenous to India. Besides the *Bombyx mori*, the Doctor enumerates the following seven species, formerly unknown:—1. The wild silkworm of the central provinces, a moth not larger than the *Bombyx mori*. 2. The Joree silkworm of Assam, *Bombyx religiosa*, which spins a cocoon of a fine filament, with much lustre. It lives upon the pipul tree *(Ficus religiosa)*, which abounds in India, and ought therefore to be turned to account in breeding this valuable moth. 3. *Saturnia silhetica*, which inhabits the cassia mountains in Silhet and Dacca, where its large cocoons are spun into silk. 4. A still larger *Saturnia*, one of the greatest moths in existence, measuring ten inches from one end of the wing to the other; observed by Mr. Grant in *Chirra Punjee*. 5. *Saturnia paphia*, or the Tusseh silkworm, is the most common of the native species, and furnishes the cloth usually worn by Europeans in India. It has not hitherto been domesticated, but millions of its cocoons are annually collected in the jungles, and brought to the silk factories near Calcutta and Bhagelpur. It feeds most commonly on the hair-tree *(Zizyphus jujuba)*, but it prefers the *Terminalia alata*, or Assam tree, and the *Bombyx heptaphyllum*. It is called *Koutkuri mooga*, in Assam. 6. Another *Saturnia*, from the neighbourhood of Comercolly. 7. *Saturnia assamensis*, with a cocoon of a yellow-brown color, different from all others, called *mooga*, in Assam; which, although it can be reared in houses, thrives best in the open air, upon trees, of which seven different kinds afford it food. The *Mazankoory mooga*, which feeds on the Adakoory tree, produces a fine silk, which is nearly white, and fetches 50 per cent. more than the fawn-colored. The trees of the first year's growth produce by far the most valuable cocoons. The mooga which inhabits the soom-tree, is found principally in the forests of the plains and in the villages. The tree grows to a large size, and yields three crops of leaves in the year. The silk is of a light fawn color, and ranks next in value to the Mazankoory. There are generally five breeds of mooga worms in the year: 1. In January and February; 2. In May and June; 3. In June and July; 4. In August and September; 5. In October and November; the first and last being the most valuable.

The Assamese select for breeding such cocoons only as have been begun to be formed in the largest number on the same day, usually the second or third after the commencement; those which contain males being distinguishable by a more pointed end. They are put in a closed basket suspended from the roof; the moths, as they come forth, having room to move about, after a day, the females (known only by their large body) are taken out, and tied to small wisps of thatching-straw, selected always from over the hearth, its darkened color being thought more acceptable to the insect. If out of the batch there should be but few males, the wisps with the females tied to them are exposed outside at night; and the males thrown away in the neighbourhood find their way to them. These wisps are hung upon a string tied across the roof, to keep them from vermin. The eggs laid after the first three days are said to produce weak worms. These wisps are taken out morning and evening, and exposed to the sunshine, and in ten days after being laid, a few of them are hatched. The wisps being then hung up to the tree, the young worms find their way to the leaves. The ants, whose bite is fatal to the worm in its early stages, are destroyed by rubbing the trunk of the tree with molasses, and tying dead fish and toads to it, to attract these rapacious insects in large numbers, when they are destroyed with fire; a process which needs to be repeated several times. The ground under the trees is also well cleared, to render it easy to pick up and replace the worms which fall down. They are prevented from coming to the ground by tying fresh plantain-leaves round the trunk, over whose slippery surface they cannot

crawl; and they are transferred from exhausted trees to fresh ones, on bamboo platters tied to long poles. The worms require to be constantly watched and protected from the depredations of both day and night birds, as well as rats and other vermin. During their moultings they remain on the branches; but when about beginning to spin, they come down the trunk, and being stopped by the plantain-leaves, are there collected in baskets, which are afterwards put under bunches of dry leaves, suspended from the roof, into which the worms crawl, and form their cocoons—several being clustered together; this accident, due to the practice of crowding the worms together, which is most injudicious, rendering it impossible to wind off their silk in continuous threads, as in the filatures of Italy, France, and even Bengal. The silk is, therefore, spun like flax, instead of being unwound in single filaments. After four days, the proper cocoons are selected for the next breed, and the rest are uncoiled. The total duration of a breed varies from 60 to 70 days, divided into the following periods:—

Four moultings, with one day's illness attending each	20
From fourth moulting to beginning of cocoon	10
In the cocoon 20, as a moth 6, hatching of eggs 10	36
	66

On being tapped with the finger, the body renders a hollow sound, the quality of which shows whether they have come down for want of leaves on the tree, or from their having ceased feeding.

As the chrysalis is not soon killed by exposure to the sun, the cocoons are put on stages, covered up with leaves, and exposed to the hot air from grass burned under them; they are next boiled for about an hour in a solution of the potash made from incinerated rice stalks; then taken out, and laid on cloth folded over them to keep them warm. The floss being removed by hand, they are then thrown into a basin of hot water to be unwound; which is done in a very rude and wasteful way.

The plantations for the mooga silkworm in Lower Assam amount to 5000 acres, besides what the forests contain, and yield 1500 maunds of 84 lbs. each per annum. Upper Assam is more productive.

The cocoon of the *Koutkuri mooga* is of the size of a fowl's egg; it is a wild species, and affords filaments much valued for fishing-lines.

8. The *Arrindy*, or *Eria* worm, and moth, is reared over a great part of Hindustan, but entirely within doors. It is fed principally on the *Hera*, or *Palma christi* leaves, and gives sometimes 12 broods of spun silk in the course of a year. It affords a fibre which looks rough at first; but when woven, becomes soft and silky, after repeated washings. The poorest people are clothed with stuff made of it, which is so durable as to descend from mother to daughter. The cocoons are put in a closed basket, and hung up in the house, out of reach of rats and insects. When the moths come forth, they are allowed to move about in the basket for twenty-four hours; after which the females are tied to long reeds or canes, twenty or twenty-five to each, and these are hung up in the house. The eggs that are laid the first three days, amounting to about 200, alone are kept; they are tied up in a cloth, and suspended to the roof till a few begin to hatch. These eggs are white, and of the size of turnip-seed. When a few of the worms are hatched, the cloths are put on small bamboo platters hung up in the house, in which they are fed with tender leaves. After the second moulting, they are removed to bunches of leaves suspended above the ground, beneath which a mat is laid to receive them when they fall. When they cease to feed, they are thrown into baskets full of dry leaves, among which they form their cocoons, two or three being often found joined together.

9. The *Saturnia trifenestrata*, has a yellow cocoon of a remarkably silky lustre. It lives on the soom-tree in Assam, but seems not to be much used.

SUMMER DRINKS.*

Ginger Beer in Bottles.—Put into any vessel 1 gallon of boiling water, 1 lb. of common loaf-sugar, 1 ounce of best ginger, (bruised), 1 ounce of cream of tartar, or else a lemon sliced. Stir them up until the sugar is dissolved, let it rest until about as warm as new milk, then add one table-spoonful of good yeast, poured on to a bit of bread put to float on it. Cover the whole over with a cloth, and suffer it to remain undisturbed 24 hours; then strain it and put it into bottles, observing not to put more in than will occupy three-quarters of their capacity, or as we usually say, three-quarters full. Cork the bottles well, and tie the corks, and in two days, in warm weather, it will be fit to drink. If not to be consumed till a week or a fortnight after it is made, a quarter of the sugar may be spared. The above quantity of ingredients will make 18 bottles, and cost 10d.

Common Ginger Beer.—That common drink sold in the streets is made with raw sugar or treacle, half a pound to a gallon of water, the ginger ground, and without the acid, costing one farthing per bottle.

Lemonade in Bottles.—This differs in no degree in manufacture from ginger beer, the ginger being left out, and 18 drops of the essence or of the oil of lemon being first ground up with the sugar—the essence is the same as the oil of lemon, but mixed with spirits of wine; it therefore unites readily with the other ingredients, and is more convenient in use.

Soda Powders are tartaric acid and carbonate of soda. Procure an ounce of each, and divide it into sixteen portions, wrap up the acid in one colored paper, and the soda in another (merely for the sake of distinction when used); dissolve one of each kind in half a tumbler of water, mix the two solutions together, and take it immediately. The above method of mixing is very inconvenient, because the effervescence is so rapid that it overflows the glass; it is better first to dissolve the soda in all the water, then add the acid in powder, and drink immediately. Using equal quantities, the drink will be slightly acid, which to most persons is agreeable; citric acid may be used instead of the tartaric, and will be found an improvement.

Soda Water in Bottles.—Dissolve one ounce of the carbonate of soda in a gallon of water, put it into bottles, in the quantity of a tumbler full or half a pint to each; having the cork ready, drop into each bottle half a drachm of tartaric or citric acid in crystals, cork and wire it immediately, and it will be ready for use at any time.

Lemonade Powders.—Pound and mix together half a pound of loaf-sugar, one ounce of carbonate

of soda, and three or four drops of the *oil* of lemon; divide the mixture into 16 portions, and use them instead of the soda alone, as recommended under soda water.

Ginger-beer Powders.—Take away the oil of lemon from the former receipt, and substitute a few grains of finely-powdered ginger, or else a few drops of the essence of ginger.

Seidlitz Powders.—Take one drachm, that is an eighth part of an ounce, of bi-carbonate of potass, and two drachms of tartarized soda, dissolved in a tumbler three parts full of water, add to this one drachm of citric or tartaric acid, and drink while in a state of effervescence.

In all the above recipes lemon-juice may be used, two table-spoonsful of lemon-juice being equal to one drachm of tartaric acid.

ANALYSING GERMAN SILVER.

BY J. C. BOOTH.

The following method of analysis may be successfully practised by any one who possesses a little chemical knowledge. A small piece of about 20 grains is dissolved in nitro-muriatic acid with the assistance of a gentle heat, by which means the metals will be converted into chlorides. If the solution be filtered through a small paper filter, and a white powder remain after washing in water, it is the chloride of silver, the presence of which metal in the compound is accidental and scarcely appreciable. The acidulated solution is then treated with sulphuretted hydrogen, which separates copper and a little arsenic. The sulphuret of copper is collected on a filter, treated with nitric acid in a gentle heat, till the sulphur appears whitish, then filtered, brought to boiling, precipitated with caustic potass, filtered, and weighed: 100 parts of this precipitate contain 79·83 of metallic copper. To the solution, after filtering off the sulphate of copper, a little nitric acid is added, and the whole heated in order to convert the protoxide into the peroxide of iron. Muriate of ammonia is then added to the same, and a small excess of ammonia, which precipitates only the proxide of iron. This may be collected on a filter, and weighed: 100 parts of it contain 69·34 of metallic iron. The solution is now to be treated with carbonate of soda, and evaporated to dryness; the dry mass is treated with hot water, and the residue washed and dried. This powder, consisting of carbonate of zinc and nickel, is mixed with half its weight of saltpetre, and ignited until the whole is nearly dry. It is transferred to a filter after being powdered in a small mortar, and is then washed two or three times with pure, but dilute, nitric acid, which dissolves the oxide of zinc, and leaves the *peroxide* of nickel. To the zinc solution carbonate of soda is added, the whole evaporated to dryness, treated with hot water, and the remainder after being dried and ignited is weighed: 100 parts contain 80·13 metallic zinc. The peroxide of nickel is dissolved in hydro-chloric acid, precipitated by caustic potassa, filtered off and weighed: 100 parts of it contain 78·71 of metallic nickel.

The separation of nickel and zinc is ever, attended with difficulty and some uncertainty, but is rendered much more simple by the method above proposed, and which is not more inaccurate than others in use. Before weighing any of the above oxides, it is decidedly preferable to burn the filter after shaking off as much of the substance as possible into a platinum crucible; to add the ashes, and then subtract their weight from that of the oxide.

MISCELLANIES.

Photometry.—Dr. Ure having failed in obtaining accurately the intensities of different lights, by a comparison of the relative shadows they project—has employed the following photometric means. He placed several pieces of paper, prepared with the salts of silver as for the photogenic drawings, in the rooms of a house darkened by a high wooden wall, or board, before the windows; and also in those of a neighbouring house not so circumstanced. In a certain time, those exposed to the action of free daylight acquired a certain depth of tint; and by observing the time required to produce the same tint on those papers placed in the darkened room, Dr. Ure was enabled to determine the amount of daylight so diminished. By photogenic impressions, Dr. Ure considers the relative degrees of diurnal illumination in different rooms in any house, in different countries, or on different days in the same house or country, also the extent or strength of daylight in any part of the world, may be correctly measured and registered.

Oil of Lemons is made from the rind of the fruit, by soaking, pressing, boiling, and afterwards skimming off the oil. It is also made from distillation.

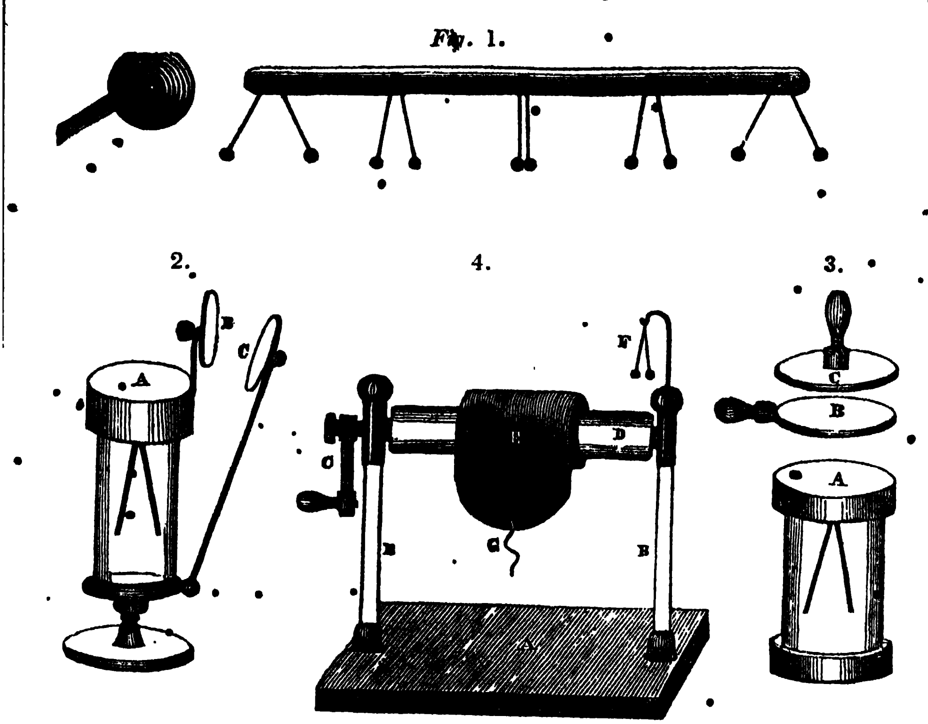
Essence of Lemons is the above mixed with spirits of wine, though the oil is often called essence.

Syrup of Lemons is the same boiled with sugar, or it may be made thus:—Rub the rind of a lemon on to loaf sugar, till all the oil cells on the outside of the rind are broken—then dissolve the sugar in water.

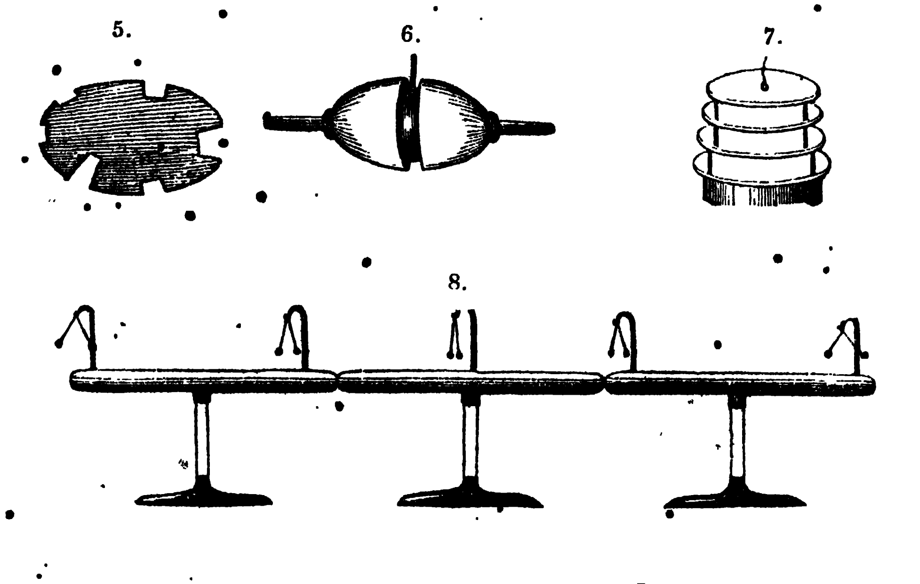
Printing in Gold and Bronze.—Take japanner's gold size, and grind in it a yellow—any kind will do, as the color is merely to give it a little stronger consistence, and to cover any imperfection in the printing. When the size is prepared to the consistence of treacle, it must be applied to the types in the same manner as printing ink, and when the impression is taken it is then covered with fine gold bronze, by means of a hare's foot. In some cases leaf-gold is applied, and pressed on with a little cotton wool. Enamelled paper or cards are the best for printing in gold upon. Printing in silver, and in bronze, is conducted in the same manner.

Fecundity of Herrings.—If all the ova of a herring were fecundated, a very few years would be sufficient to make its posterity fill the whole ocean: for every oviparous fish contains thousands of ova, at spawning time. Let us suppose, that the number of ova amount only to 2000, and that these produce as many fish, half males and half females; in the second year there would be more than 200,000; in the third, more than 200,000,000; and in the eighth year, the number would exceed that expressed by 2 followed by twenty-four ciphers. As the earth contains scarcely so many cubic inches, the ocean, if it covered the whole globe, would not be sufficient to contain all these fish, the produce of one herring in eight years.

Several other animals, such as rabbits and cats, which go with young only for a few weeks, would multiply still faster; in 50 years the earth would not afford them food, nor even contain them.



ELECTRICAL INDUCTION AND DISTRIBUTION.



ELECTRICITY.

(Resumed from page 315, Vol. I.)

It is a matter of some difficulty to decide upon the place occupied by the electric fluid that is inherent in all bodies. There appears reason to conclude that the whole matter of which any substance is composed is equally imbued with this subtile power; this in fact is proved by the law of electrical attraction, and also that by galvanism and magnetism so great and continuous a stream is produced. It is also no less demonstrable, that we can, by the violent and sudden transference of a stream of free electricity, or as it is called a shock, disturb the fluid in the inner portions of whatever conductor we have used as the means of communication between the poles of the battery, and this equally well whether the surface be exposed or not.

This is disputed by other electricians, who maintain that electricity resides only upon the surface of excited or charged bodies. We will give an experiment or two, and then make a few remarks upon each of these opinions. The first was supported by Cavallo, who gives the following:—

Ex. 1.—Take a wire of any kind of metal and cover part of it with some electric substance, as rosin, sealing-wax, &c., then discharge a jar through it, and it will be found that it conducts as well with as without the electric coating; this proves that the electric fluid passes through the substance of the metal, and not over its surface.

Ex. 2.—Let a person hold the wire connected with one surface of a charged battery in one hand, and touch the other surface with the other hand, the shock will pass not over his body, but through it, and affect him in the wrists, arms or chest, according to its strength.

Although these experiments prove that in violent cases the electric fluid may be made to pass through the interior of bodies, yet it by no means implies that when charging a body with electricity we necessarily drive it beneath the surface; on the contrary, both reasoning and experiment prove that in the ordinary transference and accumulation of the fluid, it resides but on the surface. Priestly and Cavallo proved this in former times, and Coulomb, by the assistance of his admirable and delicate tortion Electrometer, (see Vol. I.) has confirmed the truth of the proposition, and proved the truth of the law "*that the quantity of fluid capable of being made apparent by excitation or transference is in proportion to the surface of a body, and not according to its solidity.*" Thus a hollow conductor is always as efficacious as one which is solid. A large conductor will accumulate more than a small one of more solid materials. The power of a Leyden jar is in proportion to the surface, and not to the thickness of the glass—and so on in numberless other similar instances. In fact it may be said, that although the glass rods used as supports to any parts of the apparatus are usually made solid for the sake of strength, yet the thinner glass cylinders jars, conductors, &c., are made, usually the better the machine works.

The following experiments will be read with interest.

Ex. 3.—Support upon a glass rod a wooden ball, and bore various holes to different depths upon its surface, as represented in section at Fig. 5; then support a wafer covered with gold-leaf upon a very fine and dry rod of shell lac. Charge the wooden ball by holding near it an excited glass tube. While it remains charged, touch its surface with the supported gilt wafer, which immediately hold to a very delicate electrometer; this will show that the wafer has imbibed some of the electricity from the surface of the ball. Again, pass the gilt wafer quickly and neatly to the bottom of one of the holes, withdraw it, and upon holding it to the electrometer no effect will be produced.

Ex. 4.—*The Electric Well.*—Place upon an electric stool a metal quart pot, mug, or some other conducting body nearly of the same form and dimension, then tie a short cork ball electrometer; that is, two cork balls suspended on a linen thread, to a silken cord. Electrify the mug, and hold the electrometer within it, when it will not be at all affected.

Ex. 5.—Instead of the electrometer in the last experiment use a metallic ball, suspended by silk; electrify the mug and withdraw the ball, it will be found not charged by its contact with the inner surface of the mug, though it may have been struck against its sides many times.

Ex. 6.—Biot, the celebrated French electrician, constructed the apparatus shown in Fig. 6. It consists of an oval metal ball, suspended by silk and covered with two caps, each furnished with a glass handle as represented, made of paper and covered with tin-foil, and such that when united they accurately fit the surface of the inner ball. Let there be communicated to the ball any degree of electricity, then let the two caps, held by their insulating handles, be carefully applied to its surface. Upon the removal of these caps, it will be found that the whole of the electricity has been abstracted from the spheroid, so that it will no longer affect the most delicate electrometer, while the two caps will be found to have acquired precisely the same quantity of electricity which had at first resided in the ball.

The next circumstance to be observed is the effect of an extended or contracted surface in rendering apparent a minute quantity of electricity. It is not to be supposed that the communication of a trifling amount of force will affect a large body—or, that a little fluid spread over an extended space will be so apparent as if more concentrated. In electricity, as in mechanics, the means must be proportionate to the end to be effected, and that which will influence sensibly a small conductor will be unappreciable on one which is larger. Thus electrical intensity may be less, though the quantity is the same. This is illustrated by the following experiments of Biot, Coulomb, and Cavallo:

Ex. 7.—Fig. 4 represents the apparatus required. A, is a stand. B B, two rods of glass. C, a handle to turn the cylinder of glass D. E, is a long strip of tin-foil, about 2 inches wide and 2 feet long. F, is a pair of pith balls connected by a strip of tin-foil with E. G, is a silk string attached to F. On electrifying the cylinder, or rather the metal coil E, the balls of the electrometer diverge; upon taking hold of the silk thread, and unrolling the metallic lamina from the cylinder, the balls gradually collapse, thus indicating a diminution of electrical intensity. Again, winding up the lamina the balls will diverge as at first, making an allowance for a trifling dispersion of the fluid during the experiment.

Ex. 8.—Make a number of pasteboard plates, cover them with tin-foil, and suspend them from

each other by a metallic thread, a handle of glass or a silk cord being attached to the upper plate. Let the plates rest on each other, and place the whole together upon the top of a gold leaf electro meter, electrify them so that the gold leaves diverge; then gradually draw them up by the silk thread at the top, when the diverging will diminish in proportion, and again increase when let down as at first. (See Fig. 7.)

Ex. 9.—Insulate a metallic cup, or any other concave piece of metal, and place within it a pretty long metallic chain, having a silk thread tied to one of its ends. To a wire proceeding from the cup suspend a pith ball electrometer. Then electrify the cup by giving it a spark with a knob of a charged bottle, and the balls of the electrometer will diverge. Lift up one end of the chain, when the balls will diverge, let it down again and they recede as at first.

Ex. 10.—Excite a long strip of flannel, or a silk riband, by rubbing it with the fingers, then holding the knuckle to it, take as many sparks as the riband will give, but when the riband or flannel has lost the power of giving any more sparks in this manner double or roll it up; by which operation the flannel appears to be so strongly electrical; that it not only gives sparks to the hand brought near, but throws out spontaneous brushes of light, which appear very beautiful in the dark.

This article has extended so much farther than we anticipated, that we cannot fully enter into the subject of *Electrical Induction*, but will only explain the Figures 1, 2, 3, 8, and give the experiments resulting from them, leaving their explanation for a future opportunity. To understand these however, even in a cursory degree, it is necessary to observe that when a charged body comes near one that is not charged, it affects the fluid contained in that uncharged body, and drives it to a distance; thus suppose in Fig. 1, an electrified ball be held towards a long conductor furnished with electrometers at regular distances, it will drive away the fluid from the end nearest to the ball, to that which is more distant, and all the electrometers except the centre ones will be affected; those nearest to the excited body will be electrified minus because the fluid has been repelled; the next pair also minus, but in a less degree, the centre pair will be unaffected; the fourth pair will be electrified plus, as having received a part of the fluid from the other end, and the fifth and last pair will be just as strongly over-charged as the first pair was deficient.

Ex. 13.—Figure 8, shows how the result may be still more accurately ascertained. It represents three conductors furnished with electrometers. A charged body held at one end will electrify the whole. When thus charged, carefully withdraw the central conductor, when those at each end will be charged, one positively, the other negatively. This will be seen by holding each to another electrometer, or by joining them together, when the divergence of the balls will cease, the one conductor neuteralizing the other.

Ex. 14.—Figure 2, shows an electrical doubler attached to a gold leaf electrometer, if the charge communicated be too feeble to be detected by the gold leaves, it may be made apparent by approaching C to B, which will drive the small portion of fluid to the most distant part, or to the extremities of the gold leaves, when it will become apparent by their divergence.

Ex. 15.—Figure 3, represents another electrical doubler, call d *Volta's condensing plates*. The upper plate C is formed of metal or wood covered with tin-foil and furnished with a glass handle. B, is a semi-conducting plate; piece of baked wood, marble, or pasteboard answers well, the latter should be heated during the experiment. A, is a common gold leaf electrometer. To use this apparatus, put the plate C upon the plate B, and there let it rest, connected for example with a pointed wire extended some distance into the atmosphere. Although the pointed wire may collect, if attached to the electrometer so little fluid as to be unappreciable, yet connected with this upper plate C; this plate will concentrate the quantity until it by being let down upon A, will, by electrical induction affect the fluid of gold leaves, and render the experiment successful.

(Continued on page 114.)

HORTUS SICCUS;

OR PREPARATION OF SPECIMENS OF PLANTS.

(From Withering's Botany.)

MANY methods have been devised for the preservation of plants; we shall relate only such as have been found most successful.

First prepare a press, which a workman may make by the following directions:—

Take two planks of well-seasoned wood, not liable to warp. For this purpose none will prove more serviceable than elm. The planks should be wo inches thick, eighteen inches long, twelve inches broad. To regulate the degree of pressure screws were formerly used, but wedges have been found preferable, as more manageable and efficacacious. Provide, therefore, two wedges of well-seasoned wood, to pass through uprights affixed to each end of the lower plank, and rising through the upper one. When a press is not at hand, the specimens may be dried tolerably well between the leaves of a large folio book, laying other books upon it to give it the necessary pressure; but in all cases too much pressure must be avoided.

Secondly, get a few sheets of strong card pasteboard, and half a dozen quires of large, soft, spongy paper: such as the stationers call blossom blotting paper, is the most proper.

The plants you wish to preserve should be gathered in a dry day, after the sun has exhaled the dew; taking particular care to collect them in that state wherein their generic and specific characters are most conspicuous. Carry them home in a tin box, which may be made about nine inches long, four inches and a half wide, and one inch and a half deep. Get the box made of the thinnest tinned iron that can be procured; and let the lid open upon hinges. The box should be painted, or lackered, to prevent its rusting. If any thing happen to prevent the immediate use of the specimens you have collected, they will be kept fresh two or three days in this box, much better than by putting them in water; but the blossoms of some plants are so delicate, that they shrivel and fall off in a very short time, and often before you can well examine them. In this case, put the stem in water, cover the whole with a glass bell, like those used in gardens, or the receiver of an air-pump will do; expose them to the sun, and in half an hour you will find them completely expanded. When you are about to preserve them, lay them down upon a pasteboard, as much as possible in their natural form, but at the same time with a particular view to their generic

and specific characters. For this purpose it will be advisable to separate one or more of the flowers, and to display them so as to show the generic character. If the specific character depend upon the flower, or upon the root, a particular display of that will be likewise necessary. When the plant is thus disposed upon the pasteboard, cover it with eight or ten layers of the blotting paper, and put it into the press. Exert only a small degree of pressure, for the first two or three days; then examine it, unfold any unnatural plaits, rectify mistakes, and after putting fresh paper over it, drive the wedges a little tighter. In about three days more, separate the plant from the pasteboard, if it be sufficiently firm to allow of a change of place; put it upon a dry fresh pasteboard, and covering it with fresh blossom paper, let it remain in the press a few days longer. The press should stand in the sunshine, or within the influence of a fire, for nothing is so destructive to the beauty of the specimens as a long continued dampness. Shrubs and many of the harder perennial plants will lie much neater in the herbarium, if the bark of the principal stem be slit up with the point of a sharp knife, so as to allow the inner woody part to be extracted.

When the specimen is perfectly dry, the usual method is to fasten it down with glue, or paste, or gum-water, on the right hand inner page of a sheet of large strong writing paper. It requires some dexterity to glue the plant neatly down, so that none of the gum or paste may appear to defile the paper. Press it gently again for a day or two, with a half sheet of blossom paper between the folds of the writing paper. When it is quite dry, write upon the left hand inner page of the paper, the name of the plant, the specific character; the place where, and the time when it was found; and any other remarks you think proper. Upon the back of the same page, near the fold of the paper, write the name of the plant, and then place it in your cabinet. A small quantity of finely powdered arsenic, or corrosive sublimate, is frequently mixed with the paste or gum-water, to prevent the devastations of insects; but the seeds of Staves-acre finely powdered, will answer the same purpose, without being liable to corrode or to change the color of the more delicate plants. A little alum added to the paste makes it keep longer, and a little very coarse brown sugar dissolved in the gum-water renders it less brittle when dry. Some botanists put the dried plants into the sheets of writing paper without fastening them down at all, which I think much the most useful way: others only fasten them by means of small slips of paper, pasted across the stem or branches, and others again sew them to the paper with a needle and fine thread.

Another more expeditious method is to take the plants out of the press, after the first and second day, let them remain upon the pasteboard; cover them with five or six leaves of blossom paper, and iron them with a hot smoothing iron, until they are perfectly dry. If the iron be too hot it will change the colors; but some people taught by long practice, succeed very happily. This is the best method to treat the different species of Orchis and other slimy mucilaginous plants.

I am indebted to T. Velley, Esq for the following improved method of drying plants, which, being the result of much experience, cannot but prove acceptable to the practical botanist:—

"—— I place the plant, when fresh, between several sheets of blotting paper, and iron it with a *large* smooth heater, pretty strongly warmed, till all the moisture is dissipated. The flowers and fructification I fix down with gum, upon the paper on which they are to remain, and iron them in that state, by which means they become almost incorporated into the paper in their proper forms. Many colors I have been able to fix, which frequently forsook the flowers during the gradual and tedious process of sand-heats, and other methods which I had before tried.

"Some plants require a more moderate heat than others: experience must determine this: and herein consists the nicety of the experiment. The forms and colors seem to remain more perfect by this mode than by any other I have been able to try."—If the mucilaginous and succulent plants do not succeed so well with respect to their color, under the hot smoothing iron, I have always found that they failed full as much, or more, when preserved by other means. The colors of the blossoms in the class Didydamia, I could never fix by a sand-heat. Several of these, as well as of the rough-leaved plants, I have preserved tolerably well by ironing.

"It is necessary to observe, that in compound flowers, or in those of a solid and more stubborn form, as the Centaurea, &c., some little art must be employed in cutting away the under part, by which means the profile and form of the flowers will be more distinctly exhibited, provided they are to be pasted down."——"After all, it must be remembered, that a plant, when preserved in a most perfect state, is a kind of Hygrometer, and if exposed for any time to a moist atmosphere, or laid up in a situation which is not perfectly dry, will imbibe a degree of humidity that must soon prove injurious to the beauty of the specimen."

Major Velley sent me some plants dried by these means, which are the most beautiful specimens I have seen. The facility of drying plants by ironing must render this method particularly acceptable to the travelling botanist.

(Continued on page 74.)

VARNISHING.

(Resumed from page 32.)

Sandarac Varnish.

8 oz. gum sandarac,
2 oz. pounded mastic,
4 oz. clear turpentine,
4 oz. pounded glass, and
32 oz. alcohol.

Mix and dissolve as before.

Compound Sandarac Varnish.

3 oz. pounded copal of an amber color.
6 oz. gum sandarac,
3 oz. mastic, cleaned,
2½ oz. clear turpentine,
4 oz. pounded glass, and
32 oz. pure alcohol.

Mix these ingredients, and pursue the same method as above.

This varnish is destined for articles subject to friction, such as furniture, chairs, fan-sticks, mouldings, &c., and even metals, to which it may be applied with success. The sandarac gives it great durability.

Camphorated Sandarac Varnish for cut Paper Works, Dressing Boxes, &c.

No. 1.—6 oz. gum sandarac,
4 oz. gum elemi,
1 oz. gum anima,
½ oz. camphor,
4 oz. pounded glass, and
32 oz. pure alcohol.

Make the varnish according to the directions given. The soft resin must be pounded with the dry bodies. The camphor is to be added in pieces.

No. 2.—6 oz. gallipot, or white incense,
2 oz. gum anima,
2 oz. gum elemi,
4 oz. pounded glass, and
32 oz. alcohol.

Make the varnish with the precautions indicated for the compound mastic varnish.

The two last varnishes are to be used for ceilings and wainscots, colored or not colored: they may even be employed as a covering to parts painted with strong colors.

Spirituous Sandarac Varnish for Wainscotting small Articles of Furniture, Balustrades, &c.

No. 1.—6 oz. gum sandarac
2 oz. shell lac,
4 oz. colophonium, or resin,
4 oz. white glass powdered,
4 oz. clear turpentine, and
32 oz. pure alcohol.

Dissolve the varnish according to the directions given for compound mastic varnish.

This varnish is sufficiently durable to be applied to articles destined to daily and continual use. Varnishes composed with copal ought, however, in these cases, to be preferred.

Colored Varnish for Violins, and other stringed Instruments, also for Mahogany, Rose-wood, &c.

4 oz. gum sandarac,
2 oz. seed lac,
1 oz. mastic.
1 oz. benjamin in tears.
4 oz. pounded glass,
2 oz. Venice turpentine, and
32 oz. pure alcohol.

The gum sandarac and lac render this varnish durable: it may be colored with a little saffron or dragon's blood.

Fat Varnish of a gold color.

8 oz. amber,
2 oz. gum lac,
8 oz. drying linseed oil, and
16 oz. essence of turpentine.

Dissolve separately the gum lac, and then add the amber, prepared and pulverized, with the linseed oil and essence very warm. When the whole has lost part of its heat, mix in relative proportions tinctures of annatto, of terra merita, gum guttæ, and dragon's blood. This varnish when applied to white metals gives them a gold color.

Fat Turpentine or Golden Varnish, being a mordant to gold and dark colors.

16 oz. boiled linseed oil,
8 oz. Venice turpentine, and
5 oz. Naples yellow.

Heat the oil with the turpentine; and mix the Naples yellow pulverized. Naples yellow is an oxide of lead. It is substituted here for resins, on account of its drying qualities, and for its color, which resembles that of gold; great use is made of the varnish, in applying gold leaf.

The yellow, however, may be omitted when this species of varnish is to be solid and colored coverings. In this case an ounce of litharge to each pound of composition may be substituted in its stead, without this mixture doing any injury to the color which is to constitute the ground.

Turner's Varnish for Box Wood.

5. oz. seed lac,
2 oz. gum sandarac,
1½ oz. gum elemi,
2 oz. Venice turpentine,
5 oz. pounded glass, and
24 oz. pure alcohol.

The artists of St. Claude do not all employ this formula, which requires to be corrected on account of its too great dryness, which is here lessened by the turpentine and gum elemi. This composition is secure from cracking, which disfigures these boxes after they have been used for some months.

No. 2.—Other turners employ the gum lac united to a little elemi and turpentine digested some months in pure alcohol exposed to the sun. If this method be followed, it will be proper to substitute for the sandarac, the same quantity of gum lac reduced to powder, and not to add the turpentine to the alcohol, which ought to be exceedingly pure, till towards the end of the infusion.

Solar infusion requires care and attention. Vessels of a sufficient size to allow the spirituous vapours to circulate freely ought to be employed, because it is necessary that the vessels should be closely shut. Without this precaution the spirits would become weakened, and abandon the resin which they laid hold of during the first days of exposure. This perfect circulation will not admit of the vessels being too full.

In general, the varnishes applied to articles which may be put into the lathe acquire a great deal of brilliancy by polishing; a piece of woollen cloth is sufficient for the operation. If turpentine predominates too much in these compositions the polish does not retain its lustre, because the heat of the hands is capable of softening the surface of the varnish, and in this state it readily tarnishes.

To Varnish Dressing Boxes.—The most of spirit of wine varnishes are destined for covering preliminary preparations, which have a certain degree of lustre. They consist of cement, colored or not colored, charged with landscapes and figures cut out in paper, which produces an effect under the transparent varnish: most of the dressing boxes, and other small articles of the same kind, are covered with this particular composition, which, in general, consists of three or four coatings of Spanish white, pounded in water, and mixed up with parchment glue. The first coating is smoothened with pumice-stone and then polished with a piece of new linen and water. The coating in this state is fit to receive the destined color, after it has been ground with water, and mixed with parchment glue diluted with water. The cut figures with which it is to be embellished are then applied, and a coating of gum, or fish-glue, is spread over them, to prevent the varnish from penetrating to the preparation and from spoiling the figures; the operation is finished by applying three or four coatings of varnish, which when dry are polished with tripoli and water, by means of a piece of cloth. A lustre is then given to the surface with starch and a bit of doe-skin or very soft cloth.

(Continued on page 67.)

DURABILITY OF STONE.

The Report recently made to the Commissioners of her Majesty's Treasury, by Messrs. Barry, De La Beche, W. Smith, and Charles H. Smith, on the Sandstones, Limestones, and Oolites of Britain, forms, with the numerous tables and results of experiments by Messrs. Daniell and Wheatstone appended to it, one of the most valuable contributions to architectural science that have been made in modern times. One hundred and three quarries are described, ninety-six buildings in England referred to, many chemical analysis of the stones given, and a great number of experiments related, showing, among other points, the cohesive power of each stone, and the amount of disintegration apparent, when subjected to Brard's process.

Of this document we have only space to quote the following:—

"Of the necessity and importance of the inquiry upon which we have been engaged, the lamentable effects of decomposition observable in the greater part of the limestone employed at Oxford, in the magnesian limestone of the Minster, churches, and other public buildings at York, and in the sandstones of which the churches and other public buildings in Derby and Newcastle are constructed, afford, among numerous other examples, incontestable and striking evidence. The unequal state of preservation of many buildings, often produced by the varied quality of the stone employed in them, although it may have been taken from the same quarry, shows the propriety of a minute examination of the quarries themselves, in order to acquire a proper knowledge of the particular beds from whence the different stones have been obtained. An inspection of quarries is also desirable for the purpose of ascertaining their power of supply, the probable extent of any given bed, and many other matters of practical importance.

"It frequently happens that the best stone in quarries is often neglected, or only in part worked, from the cost of boring and removing those beds with which it may be associated, and, in consequence, the inferior material is in such cases supplied, especially when a large supply is required in a short space of time and at an insufficient price, which is often the case with respect to works undertaken by contract.

"As an economical supply of stone in particular localities would often appear to depend on accidental circumstances, such as the cost of quarrying, the facility in transport, and the prejudice that generally exists in favor of a material which has been long in use; and as the means of transport have of late years been greatly increased, it becomes essential to ascertain whether better materials than those which have been employed in any given place may not be obtained from other, although more distant, localities, upon equally advantageous terms.

"With respect to the decomposition of stones employed for building purposes we would observe, that it is effected according to the chemical and mechanical conditions to which such stones are exposed. As regards the sandstones that are usually employed for such purposes, and which are generally composed of either quartz or silicious grains cemented by silicious, argillaceous, calcareous, or other matter, their decomposition is effected according to the nature of the cementing substance, the grains being comparatively indestructible. With respect to limestones composed of carbonate of lime, or the carbonates of lime and magnesia, either nearly pure or mixed with variable proportions of foreign matter, their decomposition depends, other things being equal, upon the mode in which their component parts are aggregated; those which are most crystalline being found to be most durable, while those which partake least of that character suffer most from exposure to atmospheric influences.

"Sandstones, from the mode of their formation, are very frequently laminated, more especially when micaceous, the plates mica being generally deposited in planes parallel to their beds. Hence, if such stone be placed in buildings, with the planes of lamination in a vertical position, it will decompose in flakes according to the thickness of the laminæ, whereas, if it be placed so that the planes of lamination be horizontal, that is, most commonly upon its natural bed, the amount of decomposition will be comparatively immaterial.

"Limestones, such at least as are usually employed for building purposes, are not liable to the kind of lamination observable in sandstones; nevertheless varieties exist, especially those commonly termed "shelly," which have a coarse laminated structure, generally parallel to the planes of the beds, and therefore, the same precaution in placing such stone in buildings so that the planes of lamination be horizontal, is as necessary as with the sandstones above noticed.

"The varieties of limestones termed Oolites, being composed of oviform bodies, cemented by calcareous matter of varied character, will, of necessity, suffer unequal decomposition, unless such oviform bodies and the cement be equally coherent and of the same chemical composition. The limestones which are usually termed "shelly" from being formed of either broken or perfect fossil shells, cemented by calcareous matter, suffer decomposition in an unequal manner, in consequence of the shells, which being for the most part crystalline, offer the greatest amount of resistance to the decomposing effects of the atmosphere.

"The effects of the chemical and mechanical causes of the decomposition of stone in buildings are found to be greatly modified according as such buildings may be situate in town or country. The state of the atmosphere in smoky and populous towns produces a greater amount of decomposition in buildings so situate, all other conditions being equal, than in those placed in the open country, where many of the aeriform products which arise from such towns, and are injurious to buildings, are not to be found.

"The chemical action of the atmosphere produces a change in the entire matter of the limestones, and in the cementing substance of the sandstones, according to the amount of surface exposed to it. The mechanical action due to atmospheric causes occasions either a removal or disruption of the exposed particles; the former by means of powerful winds and driving rains, and the latter by the congelation of water forced into, or absorbed by the external portions of the stone. These effects are reciprocal, chemical action rendering the stone liable to be more easily affected by chemical action, which latter, by constantly presenting new surfaces, accelerates the disintegrating effects of the former.

"Buildings in this climate are generally found to suffer the greatest amount of decomposition on their

southern, south-western, and western fronts, arising, doubtless, from the prevalence of winds and rains from those quarters; hence it is desirable that stones of great durability should at least be employed in fronts with such aspects.

"Buildings situate in the country appear to possess a great advantage over those in populous and smoky towns, owing to lichens, with which they almost invariably become covered in such situations, and which, when firmly established over their entire surface, seem to exercise a protective influence against the ordinary causes of the decomposition of the stone upon which they grow.

"As an instance of the difference in degree of durability in the same material subjected to the effects of the atmosphere in town and country, we may notice the several flusta of columns and other blocks of stone that were quarried at the time of the erection of St. Paul's Cathedral in London, and which are now lying in the island of Portland, near the quarries from whence they were obtained. The blocks are invariably found to be covered with lichens, and although they have been exposed to all the vicissitudes of a marine atmosphere for more than 150 years, they still exhibit beneath the lichens their original form, even to the marks of the chisel employed upon them, whilst the stone which was taken from the same quarries (selected no doubt with equal if not greater care than the blocks alluded to), and placed in the cathedral itself, is, in those parts which are exposed to the south and south-west winds, found in some instances to be fast mouldering away.

"Color is of more importance in the selection of a stone for a building to be situate in a populous and smoky town than for one to be placed in an open country, were all edifices usually become covered, as above stated, with lichens; for although in such towns those fronts which are not exposed to the prevailing winds and rains will soon become blackened, the remainder of the building will constantly exhibit a tint depending upon the natural color of the material employed."

It should be stated that the object of the above investigation was the selection of stone for building the Houses of Parliament, and the Report concludes as follows:—

"In conclusion, having weighed to the best of our judgment the evidence in favour of the various building stones which have been brought under our consideration, and freely admitting that many sandstones as well as limestones possess very great advantages as building materials, we feel bound to state, that for durability, as instanced in Southwell Church, &c., and the results of experiments, as detailed in the accompanying tables; for crystalline character, combined with a close approach to the equivalent proportions of carbonate of lime and carbonate of magnesia; for uniformity of structure; facility and economy in conversion; and for advantage of color, the magnesian limestone, or dolomite, of Bolsover Moor and its neighbourhood is, in our opinion, the most fit and proper material to be employed in the proposed new Houses of Parliament."

PREPARATION OF CATGUT.

Before we make known the preparation of the intestines of sheep, for the manufacture of various kinds of cords, we shall mention that of those made of the horse, mule, or ass, called *Lorrains*, for lathe-bands.

Grinders, polishers, and various other mechanics, use bands, or cords, manufactured from the intestines of the horse, &c., freed from the mucous membrane. The gut is taken hold of by one end; into which is thrust a wooden ball, fastened on the end of a stake, fixed in a block; below this ball are four cutting-blades; or, to render the explanation more clear, it is a cutter formed of four blades and surmounted by a wooden ball: they draw down the intestine equally over these blades, with both hands, so as to cut it into four equal strips. They take four, six, or eight, of these strips, accordingly as they wish the cord to be thicker or thinner; then tie these strips by a particular kind of knot at one end, with large twine, made on purpose, which they call a lace; and pass the end of it over a peg secured in a hole made in a post strongly fixed: at the distance of about 30 feet is placed another post with pegs, on one of which they pass these strips: near to the first post, the strips are all tied together with a new lace, which they fasten to the peg whereof we have just spoken: the workmen call this first operation the "warping." They cut these strips, and fasten them as above described, if they are long enough (which is generally the case,) being careful that the ends are always taken in with the thread, having cut them previously across, so that the seam shall not form any unequal thickness. If they are long enough, they make a second length, till the gut is all taken in, or the pegs entirely filled.

When the weft is finished, the workman places his wheels conveniently, and passes over the hook of the part the thread which holds the weft-cord: he puts on a second lace, if the wheel be strong enough to bear it; gives several turns to the wheel by means of a handle; and places the already-twisted cord over a hook. He acts the same with every woven cord; passing his hand carefully along the cord from the wheel, and cutting with his knife all those fibres or threads which will not form one body with the cord. This never shortens in drying, provided it is always gathered together at the same dimension over the pegs. Some hours having elapsed, they replace the cords upon the wheel, and twist them afresh; 12 or 15 hours afterwards they take them one after the other, and fasten the lace to a peg which they turn with the band; the wheel seldom being strong enough. This twisting being effected, they rub it with a horse-hair cord dipped in water, which they form into a bundle, and hold between their hands. This operation is called "stretching." Another twisting is made three hours afterwards; and they stretch it as forcibly as possible, after again fixing the cords over the pegs, and to the posts.

If the cord, when sufficiently dry and twisted, is not exactly even, they polish it with a piece of dog-fish skin; but if the horse-hair cord has been passed enough over it, that becomes unnecessary. When the cord is dried and stretched, it is generally sulphured. When perfectly dry, they cut the two ends near to the lace, and coil it into a ring for sale.

The instant that the workman who makes these cords receives the intestines, he is obliged to wash them; to turn them inside-out; and to steep them in a barrel, containing two pails of water, mixed with a pound of pearlash. On the morrow, he separates the mucous membrane by the ordinary means; washes the guts in a large tub of water; cuts them

into strips; puts the laces round them during the day, and gives them the first twist: the next day, he finishes them. If the cords be not sufficiently dry by the next day, he is obliged, for the sake of salubrity, to repeat the operations. After this, the fœtid odour is no longer perceptible, and he may finish the cords at leisure.

Catgut for Rackets or Battledores.—The intestines of sheep, after they have been steeped in the alkaline lye, are cut slantwise, if they are in short lengths, and sewed together; carefully placing the slants in a direction contrary to each other, that the seams may not render the cords of an unequal size. This being done, and the intestines formed into one piece, it must be soaked in ox-blood, to give it the proper color, and then be stretched on a proper frame; after which, one, two, three, or four of the intestines, according to the required size of the cord, are fixed to a piece of tape, and the other ends are turned twice round a peg. This done, the workman takes the tape, applies it to a hook on a spindle, and gives a few turns of the handle. As the cord shortens by twisting, it must be well stretched; and when this is effected, the workman squeezes the cord between his finger and thumb throughout its whole length, to remove all its humidity, and to produce an equal thickness in every part of it. One or two hours after, he twists it again, and rubs it with a horse-hair cord, wetted. Thinner cords are made of only one intestine; operating as we have before indicated.

Catgut for Whip-handles.—Sheep's intestines, prepared with potash, are used for this purpose. The workman cuts them slantwise, and sews them together, observing always to keep them of an equal size. They are then stretched, and twisted at each end: it is very rare that this sort of cord is made of two intestines. They are then bleached, by the fumes of burning sulphur, once or twice; and sometimes colored, as they readily receive any dye. Common ink is used for a black color; and red ink for a rose color, which is sometimes rendered lighter by a little sulphuric acid. A green color is given by a composition sold for that purpose, by colormen, to the manufacturers of catgut.

Catgut for Hatters' Bows.—These are made of sheep's intestines, of the longest and largest kind, after being prepared with potash, by twisting together from 4 to 12 of them, according to the size required. They are usually made from 12 to 25 feet long. During the twisting, the cord is placed in a long box, from 18 to 20 inches in breadth, and a few inches high, in order to keep it clean, and to prevent it from trailing on the ground. The box is called the *refresher*.

This kind of cord must be void of seams and knots; to accomplish which, the workman attaches the intestines to a piece of tape, hangs them on a peg, and draws the whole of them straight, to fit their other ends to another peg; in doing which, if he finds the intestines too short, he makes a hole in their ends, and threads into them short pieces, till the whole is long enough to reach the other peg, placed at a given distance from the first. These ends are then affixed to a piece of tape, and fastened to the peg. This done, he applies them to the twisting-wheel, rubbing the cord well between his finger and thumb throughout its whole length, at every turn of the wheel, in order to make it of an equal length. When about half-dry, they are exposed twice to the fumes of sulphur; after each time, the cord must be well stretched and moistened with plenty of the solution of potash, at the same time rubbing with the hair-rubber. It is then left to dry, and afterwards cut, and coiled up for sale.

(Continued on page 85.)

MISCELLANIES.

Fresh-water Plants.—It has been commonly observed by naturalists, that the plants of fresh water are more widely dispersed than those of the land. Many of the aquatic plants of the north of Europe grow also within the torrid zone. The common duck-meat *(Lemna minor)* grows all over Europe, Asia, and North America; from Pensylvania to Japan, whether eastward or westward. The common bullrush *(Typha latifolia)* is everywhere met with over the same space, including, also, the West India Islands. The causes of the wider dispersion of aquatic plants than those of land is considered to be owing to the water-fowl, which by a wonderful instinct annually migrate from a colder to a warmer climate, and as most of those plants perfect their seeds at the time the birds are preparing for their journies, it is considered that they carry the seeds with them, some of them sticking to their feathers, and others which they swallow being afterwards voided without injury.

Improved Glaze-Wheels.—The London cutlers almost generally employ glaze-wheels, made of two thicknesses of solid planks of mahogany glued together, but which are very apt to get out of round, owing to the different natures of the grain of the wood, endways and longways. The best glaze-wheels are made of pieces of alder, so combined that the peripheries of the glaze-wheels are formed of them, with their grain laid endways. It consists of two pieces of alder, crossing each other at right angles in their centres, and let half-way into each other. The four angular divisions around are filled up with radial pieces, cut out of the wood so as to present their grain endways towards the periphery of the glaze-wheel, and well fitted, jointed, and glued firmly together. This combination is, besides, strengthened by two circular plates of iron, being laid one on each side, and united, by means of screws, with every individual piece of wood composing the glaze-wheel. Square holes are made through these plates for the axis to lodge in, and, when wedged tight upon it, the periphery and sides of the glaze-wheel may be turned truly, which completes it for use.

To Measure the Contents of Pipes.—Square the diameter of the pipe in inches, and the product will be the number of lbs. of water, avoirdupois, contained in every yard's length of the pipe. If the last figure of this product be cut off or considered as a decimal, the remaining figures will give the number of ale gallons in a yard's length of the pipe; and if the product consist only of one figure, this figure will be tenths of an ale gallon. The number of ale gallons, divided by 282, will give the number of cubic inches in every three feet of the pipe, and the contents of a pipe of greater or less length may be found by proportion.

QUERIES.

195—How is engraver's blocking cement made? [Does our correspondent mean the cement used to surround an etched plate during the biting in? If so, nothing is better than shoemaker's wax.—Ed.]

196—What is the construction of the Pentograph?

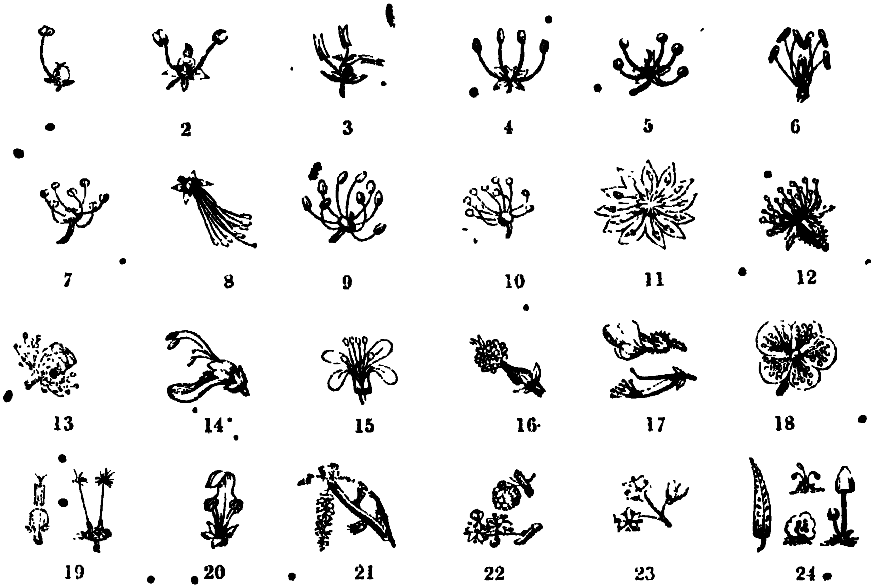
197—How are metallic pencils made, and the paper used with them?—*Answered on page 214.*

198—What is the preparation of asses' skin paper?

199—How are organ barrels pinned?—*Answered on page 146.*

200—What is the receipt for Pontypool varnish? This is common Brunswick black, or asphalte varnish.

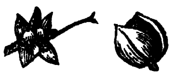
THE LINNEAN CLASSES.



THE LINNEAN ORDERS.

Applied to the first Thirteen Classes.

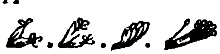
Applied to Class Fourteen.



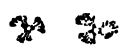
Applied to Class Fifteen.

Applied to Class Sixteen.

Applied to Class Seventeen.

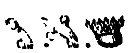


Applied to Class Eighteen.



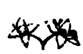
Applied to Class Nineteen.

Applied to Class Twenty.

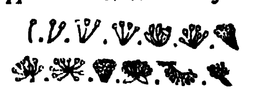


Applied to Class Twenty-one.

Applied to Class Twenty-three.



Applied to Class Twenty-two.



THE ARTIFICIAL SYSTEM OF BOTANY.

LINNÆAN ARRANGEMENT.

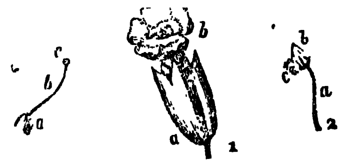
The main object of the artificial system of botanical arrangement is to facilitate the discovery of the names of plants. For this purpose some one organ, common to plants in general, is fixed on: and, according to certain conditions in which this organ is found, individual species are referred to their places in the system, as words, by their initial letters, are referred to their places in an alphabetical dictionary.

In the progress of artificial systems different organs have been fixed on by different botanists: but those which have been most extensively employed are the corollas by Tournefort, and the stamens and pistils by Linnæus. The system of Tournefort has been a good deal employed in France, and may be considered as the artificial system of that country; that of Linnæus has been employed in most other countries, and is justly esteemed by far the most perfect artificial system which has hitherto been produced.

The application of the Linnæan system in practice, Sir J. E. Smith observes, is, above all other systems, easy and intelligible. Even in pursuing the study of the natural affinities of plants, this botanist affirms, "that it would be as idle to lay aside the continual use of the Linnæan system, as it would be for philologists and logicians to slight the convenience, and indeed necessity, of the alphabet, and to substitute the Chinese character in its stead." *(Introduct. to Bot.)* "The student of the Linnæan artificial system," he elsewhere observes, "will soon perceive that it is to be understood merely as a dictionary, to make out any plant that may fall in his way." *(Gram. of Bot.)* If we examine," says Decandolle, "the artificial systems which have been hitherto devised, we shall find the most celebrated of them, that which was proposed by Linnæus, to possess a decided superiority over all others, not only because it is consistently derived from one principle, but also because the author of it, by means of a new nomenclature, has given to his terms the greatest distinctness of meaning." (*Elements of the Philos. of Plants, by Decandolle and Sprengel.*)

According to the Linnæan system all plants are furnished with flowers, either conspicuous or inconspicuous. The plants with conspicuous flowers are arranged according to the number and position of their stamens and pistils; those with inconspicuous flowers are arranged according to the situation of the flowers on the plant, or according to other circumstances in the plant itself.

To discover the name of a plant by the Linnæan system, therefore, all that is necessary for a beginner is to possess a specimen of it in flower, and to be able to know its different parts by the names given them by botanists. To discover the class, order, and genus of a plant, it is only necessary to be able to distinguish and name the different parts of the flower. These parts are: the calyx or cup Fig. 1, A, which is that leaf, or those leaves, by which the flower is usually inclosed when in bud, and which, when the flower is expanded, appear under it. The corolla (*corona*, a crown) is the colored leaf or leaves of a flower, Fig. 1, B. The stamen or first principle of any thing, is the thread-like process, or processes, immediately within the leaves of the corolla, Fig. 2; it consists of two parts, the filament or thread A, and the anther B; this anther contains what is called the pollen, or fructifying meal, C. In the centre of the flower is the pistil, Fig. 3; it consists of three parts, the germen, or rudiments of the fruit or seed, A, the style, B, and the stigma or summit, C, which crowns the style, and is destined to receive the fructifying pollen.



The pistil and stamen are the essential parts of a flower. The corolla or the calyx may be wanting, and yet the flower will be termed perfect, because the absence of those parts is no obstacle to reproduction. Even the style and the filament may be absent without preventing the formation or ripening of the fruit; and there are many flowers which have the anther sitting close to the corolla, &c., without a filament, and the stigma to the germen without a style; but the anther, the germen, and the stigma are essential.

The seed is contained in the pericarp, or seed-vessel, which is the germen when grown to maturity. The name of seed-vessel varies according to its form, substance, &c.; but the word pericarp (*peri*, about, *karpon*, a fruit) is applicable to all its varieties. The receptacle is the base or medium which connects the other parts of the fructification.

The degree of knowledge conveyed by the following Table, and the preceding observations, will enable a beginner to discover the class, order, and genus of any plant which he may find in flower.

THE LINNÆAN SYSTEM.

Observing these various circumstances, Linnæus founded his celebrated system.—First, as the easiest mark of distinction, he considered the number of stamens—when they were all of the same length, and this simple character gave him the first eleven classes. In the two next their position as well as number were taken. In the two next their length is of consequence. In the five next the stamens are joined together. In classes 21 and 22, the flowers do not contain both stamens or styles, being furnished with only one or the other. In class 23, the flowers may have stamens only, pistils only, or both, while the whole system concludes with a class which contains all those plants bearing seed, without having first produced flowers. In most of the plants of these latter classes, some peculiar popular character is distinguishable, as well as the number of stamens; thus the 14th class has personate or lipped flowers; the 15th has cruciform flowers; the 17th has pea-shaped flowers, &c.

An order is the first division of a class; and as the stamens denote the class, so the styles denote the orders, at least in the first twelve classes. In the rest, other parts are used for this purpose, as the character and position of the seed-vessel, the nature of the florets, and in some of them even the stamens themselves, when not wanted to tell the classes, as afterwards explained.

The orders of the 24th class are of a botanical rather than a popular character; they are Ferns, Mosses, Seaweeds, Lichens, and Fungi.

TABLE OF THE CLASSES.

(Plants in this division and the next have all their stamens of the same length, and distinct from each other.)

No.	Name.	Character.	No.	Name.	Character.
1..	MONANDRIA	Flowers with 1 stamen.	7..	HEPTANDRIA	Flowers with 7 stamens.
2..	DIANDRIA	Flowers with 2 stamens.	8..	OCTANDRIA	Flowers with 8 stamens.
3..	TRIANDRIA......	Flowers with 3 stamens.	9..	ENNEANDRIA....	Flowers with 9 stamens.
4..	TETRANDRIA	Flowers with 4 stamens.	10..	DECANDRIA	Flowers with 10 stamens.
5..	PENTANDRIA	Flowers with 5 stamens.	11..	DODECANDRIA ..	Flowers with 12 stamens.
6..	HEXANDRIA	Flowers with 6 stamens.			

12....	ICOSANDRIA........	more than 12 stamens, placed upon the calyx.
13....	POLYANDRIA	more than 12 stamens, placed upon the receptacle.
14....	DIDYNAMIA........	Four distinct stamens, 2 long and 2 short.
15....	TETRADYNAMIA	Six distinct stamens, 4 long and 2 short.
16....	MONODELPHIA......	Stamens united in 1 bundle by their filaments.
17....	DIADELPHIA........	Stamens united in 2 bundles by their filaments.
18....	POLYADELPHIA	Stamens united in many bundles by their filaments.
19....	SYNGENESIA........	Stamens united by their anthers, distinct from the style.
20....	GYNANDRIA	Stamens united to the style.
21....	MONOECIA	Stamens and pistils in different flowers on the same plants.
22....	DIOECIA	Stamens and pistils in different flowers upon different plants.
23....	POLYGAMIA	Some flowers with stamens and pistils, others with stamens only.
28....	CRYPTOGAMIA	Plants without flowers.

NAMES OF ORDERS APPLIED TO THE FIRST THIRTEEN CLASSES.

MONOGYNIA..........	Flowers with 1 style.	HEXAGYNIA	Flowers with 6 styles.
DIGYNIA	Flowers with 2 styles.	HEPTAGYNIA........	Flowers with 7 styles.
TRIGYNIA............	Flowers with 3 styles.	DECAGYNIA	Flowers with 10 styles.
TETRAGYNIA	Flowers with 4 styles.	DODECAGYNIA	Flowers with 12 styles.
PENTAGYNIA	Flowers with 5 styles.	POLYGYNIA	Flowers with many styles.

APPLIED TO CLASS FOURTEEN.

GYMNOSPERMIA... Seed apparently naked. | ANGIOSPERMIA... Seeds in a capsule.

APPLIED TO CLASS FIFTEEN.

SILICULOSA... Seeds in a short pod. | SILIQUOSA... Seeds in a long pod.

APPLIED TO CLASS NINETEEN.

POLYGAMIA ÆQUALIS..... All the florets perfect, or with stamens and styles.
POLYGAMIA SUPERFLUA... Inner florets perfect, outer with styles only.
POLYGAMIA FRUSTANEA .. Inner florets perfect, outer without styles.
POLYGAMIA NECESSARIA.. Inner florets with stamens, outer with styles only.
POLYGAMIA SEGREGATA .. Flowers collected into heads, each with a separate involucre.

While in all the other classes, that is, in the 16, 17, 18, 20, 22, and 23, the stamens not being wanted to tell the classes, they are used as marks of the orders, with the same names as the classes themselves—thus, here Monandria means the first order, but before it meant the first class.

This may appear puzzling, and really it is so to those who use numbers and not names; and the student is strongly recommended not to use numbers for the classes and orders, for these mean nothing; but the Greek names of them signify the same in all situations; and, moreover, express some circumstance relating to the plant.

For example, if we speak of a plant of the 14th class and 1st order, we are not reminded of anything respecting it; but if we speak of it as belonging to class Didynamia, and order Gymnospermia, we learn that there are in it two long and two short stamens, and that the seeds are not in a capsule; for these terms signify as much. Again,

The third order of class 3 is TRIGYNIA, and has three styles.
The third order of class 4 is TETRAGYNIA, and has four styles.
The third order of class 12 is POLYGYNIA, and has many styles.
The third order of class 13 is HEXAGYNIA, and has six styles.

Thus, saying that such or such a flower is of the 3d order, means nothing, for it may have 3, 4, 6, or many styles; but to say it belongs to order Trigynia, or Tetragynia, &c., shows at once partly the nature of it, for if it belong to Trigynia it must have three styles, and if to Tetragynia it must have 4 styles, and so on for the others.

CHEMICAL ELEMENTS.

HYDROGEN.

(Resumed from page 29, and concluded.)

Ex. 23.—*To purify Hydrogen.*—The gas obtained by the former experiments is never perfectly pure. To render it so, and which is necessary for delicate experiments, it must be passed through a solution of potass, then dried by passing it through a tube containing fragments of fused chloride of calcium, (muriate of lime.) The hydrogen procured by the decomposition of water by galvanism is considered perfectly pure.

Ex. 24.—*Lightness of the Gas.*—Fill a jar with hydrogen, and let it stand for a few moments with its open mouth upwards, and letting down a taper into it the gas will be found to have escaped. Put another jar filled with its mouth downwards, the gas will now remain much longer than before, being prevented from escaping by the bottom and sides of the vessel.

Ex. 25.—Provide an air jar with a stop cock and jet, and fill it with hydrogen, upon the shelf of the pneumatic trough, then set fire to the gas at the jet, and whilst it is there burning, slowly lift the jar out of the water, holding it by the brass cap. The flame will continue for some time at the jet, the hydrogen being propelled through it by its lightness, but when the air becomes mixed in such proportions with the gas as to form an explosive mixture, the flame recedes through the jet, and the whole kindles suddenly.

Note.—The jar should be very long and narrow.

Ex. 26.—*Shown by a Balloon.*—Procure a small balloon, made of the craw of a turkey, or of gold-beaters' skin, and fill it with hydrogen; tie the mouth and let it escape, it will soon mount to the ceiling of the room, or if in the open air fly out of sight immediately.

Ex. 27.—*Tendency of Oxygen and Hydrogen to unite mechanically.*—Fill a bottle with oxygen and put it on a tube, furnish it with a cork and a long tube running through it; to the upper end of the tube fasten by a second cork, a bottle of hydrogen with its mouth downwards. Notwithstanding their relative position, after a time they will be found united together, half of the hydrogen having descended to the lower bottle, and half the oxygen ascended to supply its place. The mixture may be shown to have taken place by exploding the contents of the bottle.

Ex. 28.—*Formation of Water.*—While hydrogen gas is burning in a jet, hold over the flame a bell glass, in a minute or two the inside will be covered with water, arising from the union of the hydrogen which is burning and the oxygen which it robs the air of during its combustion.—When the glass becomes hot the water is no longer seen, because though formed as before, yet the heated glass dissipates it in steam—hence the necessity of a chimney to every gas light, the frequent though not the only cause of the cloudiness of shop windows in the winter time—and the cause of cutlery and ironmongery goods becoming so often rusty. The same effect takes place in the burning of candles though less in degree.

Ex. 29.—*Attended by Explosion.*—Put a spoonful of water into a strong soda water bottle, fill it with hydrogen two parts, and oxygen one part, stand it upright on a table and let drop cautiously into it a slip of potassium. When this touches the water it will burst into flame, and fire the mixed gases. It is advisable that the bottle should be wrapped in a cloth to prevent danger, should the bottle burst which is not unlikely.

Ex. 30.—*The mixed Gases inflamed by Electricity.*—Blow some soap bubbles with a mixture of oxygen and hydrogen contained in a bladder, when separated and flying upwards, communicate to them an electric spark, they will burst with a loud noise.

Hang to the ceiling a bladder filled with the gases mixed together, pass an electric shock through it, and a deafening explosion will be the consequence.

Ex. 31.—*Increase of Bulk when exploded.*—Procure a thick glass tube at least four feet long, furnished near one end with the proper detonating wires, and also with a stop cock to supply the gases—let there be also a plug or piston, capable of an easy motion up and down the tube, but yet so as to be air-tight; exhaust the tube of air, and pass into it one portion of oxygen and two of hydrogen. The moveable piston will rest close to the gases—these are to be detonated by the electrical spark, and at the moment of detonation the piston will be driven along the tube about fifteen times as distant from the closed end as at first, making allowance for friction, arising from the weight of the piston and its rubbing against the tube. The next instant, as the gases are condensed into water, the piston will be driven back again quite to the end of the tube, by the external pressure of the atmosphere.—This tube, if graduated, is an extremely convenient eudiometer or apparatus for the following experiments:

Ex. 32.—*Composition of Water proved.*—Pass into the tube or eudiometer two cubic inches of hydrogen, and one of oxygen—upon passing the spark the two gases will exactly neutralize each other; no trace of either gas will be left, and the piston will return exactly to the place it was at before the gases were ejected; and supposing the experiment repeated several times, so as to ascertain accurately the result, the quantity of water it will be found weighs precisely the same as the united weights of both portions of the gases.

Ex. 33.—*Hydrogen unites with Oxygen only in a certain ratio.*—Pass into the tube two cubic inches of hydrogen, and two of oxygen—upon making the explosion one portion of oxygen will be left, as will be seen by the position of the piston. To prove which pass two other volumes of hydrogen, and explode; they will unite and the piston return to its first situation, showing that the whole has been condensed into water.

Ex. 34.—Pass as before two volumes of hydrogen, and five of atmospheric air—make the discharge and explosion will take place, leaving four measures of gas unconfined; which upon testing properly will be found to be wholly nitrogen, arising thus: the atmospheric air contains one-fifth oxygen and four-fifths nitrogen in its composition—the one part oxygen, leaves it to unite with the two parts of hydrogen to form water, leaving the nitrogen free.

Ex. 35.—*Power of Combination limited.*—Mix in the tube, as before, one portion of hydrogen with 12 of air, or else with 15 of oxygen, and although the spark be passed through the mixture no explosion will ensue—so also if the quantity of hydrogen be increased to 11 to 1 of the oxygen, or if the mixture be in relative and proper proportions, yet if expanded to 6 times its volume by heat, or 16 times its volume by the air-pump, no explosion will take place.

Ex. 36.—*Oxygen and Hydrogen unite by pressure.*—Fill a condensing syringe having a closed end, or as it is called "the pneumatic tinder box." with a mixture of two parts of hydrogen and one of oxygen; and upon compressing down the piston very suddenly, the gases will unite and explode—forming, as before, water.

Dr. Faraday has given a singular instance of cohesive force inducing chemical combination, by the following experiment, which seems to be nearly allied to the discovery made by M Dœbereiner, in 1823, of the spontaneous combustion of spongy platina exposed to a stream of hydrogen gas mixed with common air. A plate of platina, with extremely clean surfaces, when plunged into oxygen and hydrogen gas, mixed in the proportion which are found in the constitution of water, causes the gases to combine, and water to be formed, the platina to become red-hot, and at last an explosion to take place; the only conditions necessary for this curious experiment being excessive purity in the gases and in the surface of the plate. A sufficiently pure metallic surface can only be obtained by immersing the platina in very strong hot sulphuric acid, and then washing it in distilled water, or by making it the positive pole of a pile in dilute sulphuric acid. It appears that the force of cohesion, as well as the force of affinity, exerted by particles of matter, extends to all the particles within a very minute distance. Hence the platina while drawing the particles of the two gases towards its surface, by its great cohesive attraction, brings them so near to one another, that they come within the sphere of their mutual affinity, and a chemical combination takes place.

Dr. Faraday attributes the effect, in part also, to a diminution in the elasticity of the gaseous particles, on their sides adjacent to the platina, and to their perfect mixture or association, as well as to the positive action of the metal in condensing them against its surface by its attractive force. The particles, when chemically united, run off the surface of the metal, in the form of water, by their gravitation, or pass away as aqueous vapour, and make way for others.

IVORY PAPER.

The properties which render ivory so desirable a subject for the miniature painter, and other artists, are, the evenness and fineness of its grain, its allowing all waters colors laid on its surface to be washed out with a soft wet brush, and the facility with which the artist may scrape off the color from any particular part, by means of the point of a knife or other convenient instrument, and thus heighten and add brilliancy to the lights in his painting more expeditously and efficaciously than can be done in any other way.

The objections to ivory are, its high price, the impossibility of obtaining plates exceeding very moderate dimensions, and the coarseness of grain in the larger of these; its liability, when thin, to warp by changes of the weather. and its property of turning yellow by long exposure to the light, owing to the oil which it contains.

Traces made on the surface of this paper by a hard black lead pencil are much easier effaced by the Indian rubber than from common drawing paper, which circumstance, together with the extremely fine lines which its hard and even surface is capable of receiving, peculiarly adapts it for the reception of the most delicate kind of pencil drawing and outlines. The colors laid upon it have a greater brilliancy than when laid upon ivory, owing to the superior whiteness of the ground. Colors on ivory are apt to be injured by the transudation of the animal oil, a defect which the ivory paper is free from. The following is the process given by Mr. Einslie (of Stretton Ground, Westminster) to the Society of Arts, for which he was voted the sum of thirty guineas.

"Take a quarter of a pound of clean parchment cuttings, and put them into a two-quart pan, with nearly as much water as it will hold; boil the mixture gently for four or five hours, adding water from time to time, to supply the place of that driven off by evaporation; then carefully strain the liquor from the dregs through a cloth, and when cold it will form a strong jelly, which may be called size (No. 1.)

"Return the dregs of the preceding process into the pan, fill it with water, and again boil it as before for four or five hours; then strain off the liquor, and call it size (No. 2.)

"Take three sheets of drawing paper (outsides will answer the purpose perfectly well, and being much cheaper are therefore to be preferred,) wet them on both sides with a soft sponge dipped in water, and paste them together with the size (No. 2.) While they are still wet, lay them on a table, and place them upon a smooth slab of writing slate, of a size somewhat smaller than the paper, turn up the edges of the paper, and paste them on the back of the slate, and then allow the paper to dry gradually. Wet, as before, three more sheets of the same kind of paper, and paste them on the others, one at a time; cut off with a knife what projects beyond the edges of the slate, and when the whole has become perfectly dry, wrap a small piece of slate in coarse sand-paper, and with this rubber make the surface of the paper quite even and smooth. Then paste on an inside sheet, which must be quite free from spots or dirt of any kind; cut off the projecting edges, as before, and when dry, rub it with fine glass-paper, which will produce a perfectly smooth surface. Now take half a pint of the size (No. 1,) melt it with a gentle heat, and then stir into it three table-spoonsful of fine plaster of Paris; when the mixture is completed, pour it out on the paper, and with a soft wet sponge distribute it as evenly as possible over the surface. Then allow the surface to dry slowly, and rub it again with fine glass paper. Lastly, take a few spoonsful of the size (No. 1,) and mix it with three-fourths its quantity of water; unite the two by a gentle heat, and when the mass has cooled, so as to be in a semi-gelatinous state, pour one-third of it on the surface of the paper, and spread it evenly with the sponge; when this has dried, pour on another portion, and afterwards the remainder; when the whole has again become dry, rub it over lightly with fine glass-paper, and the process is completed; it may, accordingly, be cut away from the slab of slate, and is ready for use."

The quantity of ingredients above-mentioned is sufficient for a piece of paper 17½ by 15½ inches.

Plaster of Paris gives a perfectly white surface; oxide of zinc, mixed with plaster of Paris, in the proportion of four parts of the former to three of the latter, gives a tint very nearly resembling ivory; precipitated carbonate of barytes gives a tint intermediate between the two.

TO MEASURE LIGHT.

WHEN it is required to compare the intensities of light, produced by candles of different sizes, the following mode may be adopted. Fix a sheet of white paper against the wall of your room at a convenient height, and place a small fire-screen at a few feet distance from it, taking care to fix the part intended to throw the shadow upon the paper, at a proper height for doing so; then let one of your assistants take the candle which yields the smallest quantity of light, and proceed to such a distance from the screen as may be convenient, but so as to allow the shadow to be produced to fall upon the paper. Next, let him who holds the candle yielding the strongest light, proceed in nearly the same direction from the screen as the former, till the shadow from his candle falls nearly upon the same part of the paper as that produced by the weakest light; should the darkness of shadow from the strongest light be greater than that produced by the weaker, let your second assistant increase his distance from the interposing object till the shadow from each candle is equally dark; this being done, measure the distance of each light from the paper receiving their respective shadows: then say

As the square of the distance of the weakest light from the shadow is to unity:

So is the square of the distance of the strongest light from the shadow,

To the proportion of light it yields in comparison with the former.

But, by way of example, let us suppose we proceeded agreeably to the plan already pointed out, with two candles of different illuminating powers, and have measured the distances of each from the shadows, and found the weaker light to be at 6 feet distance from the shadows, and the stronger light at 12 feet, and desire to know how many candles of the least illuminating power, if placed in the same situation as to distance from the interposing object, as the strongest light would produce a shadow equally strong and consequently yield the same quantity of light.

The square of 6 is equal to 36
Do.......12.........144

therefore as 36 as 1 :: 144 to 4 the number of candles of the smaller illuminating power which would be required to be all lighted at one time, and placed close to each other to produce the same intensity of light with the larger candle.

Having adjusted the flame of a gas burner to 2 inches in height, and placed an opaque body between it and a sheet of white paper, attached to a wall 12 feet distance from the burner, a mould candle, of 6 to the pound, was introduced between the burner and the body, producing the shadow, and moved backwards and forwards till the shadow produced by the gas burner and the candle were equally dark; on their being so, the candle was found by measurement to be 4.9.10ths feet from the shadow produced; the number of such candles as would produce as much light the burner gives, are required to be shown.

The square of 4.9 = 24.01
12.0 = 144.00

Then as 24.01 : 1 :: 144 : 6 nearly, the number of candles necessary to produce the same intensity of light as afforded by the burner.

It has been determined by experiments made by Count Romford, for the purpose of ascertaining the quantity of materials necessary to produce a light of a certain intensity, for a given time, that there must be burnt by weight,

Of Wax....................	100 pounds.
Tallow..................	101 do.
Oil in an Argand lamp	129 do.
An ill-snuffed tallow candle	229 do.

and from various experiments made on the gases obtained from coal and from oil, we are enabled to state, that to procure as much light as is afforded by 100 lbs. of wax would require.

Of coal gas..............	5450 cubic feet
Oil gas about..........	2000 do.

The comparative cost of the different modes of lighting will therefore stand thus:—

100 lbs. of wax candles, at 2s. 8d. per lb........................	£13	9	4
101 lbs. of best Kensington mould candles, at 8d...............	3	7	4
120 lbs. of oil (spermaceti) at 5d.	2	13	9
229 lbs. of ill-snuffed tallow candles dips, at 7d..................	6	13	7
5150 cubic feet of coal gas, at 6s. per 1000 cubic feet	1	12	8½
2000 ditto of oil gas, at 28s. ditto	2	16	0

LANDSCAPE PAINTING.

THE colors used in landscapes are, flake white, white lead, light ochre, brown ochre, brown pink, burnt umber, ivory black, Prussian blue, ultramarine, verte, lake, Indian red, King's yellow, chrome yellow, &c.

Process.—Sketch or rub in your design faintly with burnt umber, used with drying oil and a little oil of turpentine. Remember in doing this to have no part of the shadows so dark as you intend the first lay, or dead coloring; which, also, is to be lighter than the finishing colors. Though the foliage of the trees is only rubbed in faintly, yet, the trunks and bodies should be in their proper shapes, with their breadth of light and shadow. All kinds of building should be done in the same manner—leaving the color of the cloth for their lights. The figures on the fore-ground may also be sketched in the same manner, and then left to dry.

First Painting, or Dead Coloring.—Let the first lay, or dead coloring, be without any bright, glaring, or strong dark colors, so that the effect is made more to receive and preserve the finishing colors than to show them in their first painting. The sky should be done first,—then all the distances, and so work downwards to the middle group, and from that to the foreground and nearest parts. The greatest secret in dead coloring is to find the two colors which serve for the ground of shadows in general, (the sky excepted) and the method of using them with the lights. The sky should be laid with a good body of color and left with a faint resemblance of the principal clouds. The distances should be made out faint and obscurely, with the dark shades and some of their lights in different degrees; all the grounds of the trees should be laid or rubbed in enough only to leave an idea of their shapes and shadows faintly. In painting the lights, it is better to incline more to the middle tint than to the very high lights; after this, go over the whole with a sweetener very lightly, which will soften and mix the colors agreeably, ready for finishing.

Second Painting.—Begin with the sky; and lay in all the azure and colors of the horizon, then

soften them; after that lay in the general tint of clouds, and finish on it with the high lights and the other tints that are wanting with light tender touches, then soften the whole very lightly.

The finishing of the sky should be done all at one painting. Observe that the stiffer the azure and colors of the horizon are laid, the better the clouds may be painted upon them.

The greatest distances are chiefly made with the color of the sky; as they grow nearer and darker, glaze and scumble the parts very thin with such glazing shadow colors as come nearest to the general hue of the group the objects are in. This glazing should be understood of a darkish hue, and that the first painting, or dead color, should be seen through it distinctly.

Before we proceed farther, it will be proper to say something of the most useful glazing colors. Lake, terre verte, Prussian blue, brown pink, terra Sienna, are the principal. The more you use them like Indian ink, and the more distinctly you leave them, the better their transparent beauty will stand and appear, provided you do it with good drying oil. After these glazing colors, burnt umber is a very good glazing warm brown, and is of great use in the broken grounds and nearest parts. Make out all the grounds of the objects with such glazing shadow colors as seem nearest to the natural hue of the object in that situation.

The colors that come next for finishing are in the degree of middle tints. These should be carefully laid over the greatest breadths of lights, in such manner as not to spoil and cover too much of the glazing; do it with a good body of color. According to these methods, it will be easy to finish all the second painting down from the sky through the middle group. As you come to the first group, where all the objects should be perfectly finished, finish their under or most distant parts before you paint any of the other which appear nearer.

Third and last Painting—If oiling is necessary, lay the least quantity possible, which should be done with a stump tool and pencil proportioned to the place that is to be oiled, so as to oil no more than is wanted: then wipe the whole place that is oiled with a piece of silk handkerchief. When going to finish any object remember to use a great variety of tints very nearly of the same color —but most of all when finishing trees. The method of painting near trees is, to make the first lay very near to nature, though not quite so dark, but more in the degree of a middle tint, and follow it with strengthening the shadows through the middle tints; and last of all, lay the high lights and finishing colors. All this cannot be done at one painting; therefore, the best way is to do no more than the first lay with the faint shadows and leave it to dry. Begin with improving the middle tints and shadows and let them dry; then add all the lights and finishing colors in the best manner you are able.

The figures in the landscape are the last work of the picture, those in the foreground should be done first, and those in the distances should be done next; for after the figures in the first and farthest group are painted, it will be much easier to find the proportions of those in the middle part of the picture; and observe that the shadows of the figures should be of the same hue, or color, with those of the group or place they are in.

To the Editor.

SIR.—I have perused an article in page 376, vol. I., of your valuable publication, on the convertibility of a telescope into a microscope, and cannot but coincide with your ideas on the subject. But there is another method to be pursued, which will not in any measure tend to disfigure, or otherwise injure the glass. The experiments made were upon a large and small telescope—the latter the highest in amplifying power as is, I believe, generally the case, and of the simplest kind, as follows:—

Unslip the slides, (or take off the caps, whichever it may be,) which protect the field and eye-piece glasses. Place the eye-piece under the; eye at the same time have placed underneath the field-glass the object to be magnified, and the view thus obtained will not only be without detriment to the instrument, but, if the glasses are good, as clear as for ordinary purposes could be wished.

ÆGIDIUS.

HARNESS PASTE AND POLISH.

To the Editor

SIR.—Seeing in page 8 of the *Magazine of Science*, query 185—"*What is harness polish and its preparation?*" I have taken the liberty of sending you the preparation of two, which have enjoyed the most extensive patronage for some years past.

Harness Maker's Jet.—4 oz. best glue, 1½ pint good vinegar, 2 oz. best gum arabic, ½ pint good black ink, 2 drams best isinglass.

Break the glue in pieces, put it in a basin, and pour over it about a pint of the vinegar—let it stand until it becomes soft. Put the gum in another basin, (or some other convenient vessel,) with the ink, till it is perfectly dissolved; melt the isinglass in as much water as will cover it, which may be easily done by placing the cup containing it on the hob, about an hour before you want to use it. To mix them, pour the remaining vinegar with the softened glue into a saucepan upon a gentle fire, stirring it till it is perfectly dissolved, that it may not burn to the bottom, being careful not to let it reach the boiling point—about 180 Fahr. is the best heat. Next add the gum, let it arrive at about the same heat again; add the isinglass. Take from the fire, and pour it off for use. Unless the above method of mixing the ingredients is attended to, the polish will not have that brillancy it ought to have, if it is not entirely spoiled. To use it, put as much as is required in a saucer—give it sufficient heat to make it fluid, and apply a thin coat with a piece of dry sponge—if the article is dried quickly, either in the sun, or by the fire, it will have the better polish. This answers equally well for boots or shoes.

Water-proof Harness Paste.—Put into a pipkin 2 oz. of black rosin, place it on a gentle fire—when melted add 3 oz. of bees'-wax. When this is melted take it from the fire—add ½ an oz. of fine lamp black, and ½ a dram of Prussian blue in fine powder. Stir them so as to be perfectly mixed, then add sufficient spirits of turpentine to form a thin paste—let it cool.

To use it, apply a coat, with a piece of linen rag, pretty evenly all over the harness—then take a soft polishing brush, and just brush it over, so as to obtain a bright surface.

C. P. C.

MISCELLANIES.

Answer to Query 168. "*How are Bath Bricks made?*—Bath bricks (or scouring bricks) are made in the same manner as building bricks, with one exception, viz., instead of using *clay*, as is done for building bricks, *slime* is used; an inexhaustible supply of which is found on the banks of the river at Bridgewater, Somersetshire, and appears to be a mixture of *sand* and *clay*. Bridgewater is, we believe, the only place at which scouring bricks are made. Their names then of Bath bricks and Flanders bricks are both inappropriate.

Stain of Lunar Caustic removed from Linen, the Fingers, &c.—Take of chloride of mercury 2 drams, hydrochloric acid 2 drams; dissolve. This must be applied to the stain with a camel's-hair pencil, and the linen, paper, &c., immediately plunged into water, when the stain will be removed. Let it be afterwards dried in the sun.

Another Method.—If a small piece of the iodide of potassium is rubbed on the part (which must be previously wet), it will immediately decompose the blackened oxide, and convert it into the iodide of silver, which is soluble in water, and consequently may be discharged by washing. The above process will answer equally as well for linen, muslin, &c.—hot water dissolves the iodide much quicker than cold.

New Speculum.—A new, and it may turn out important instrument has been produced on the following ingenious principle. Mr. Nasmyth, in offering to the British Association a few remarks, "On the Difficulties in the General Use of Metallic Specula for Reflecting Telescopes of very large size, in consequence of their excessive weight, and of the great nicety required in casting and grinding them," drew attention to an invention of his, viz. a plate-glass pneumatic speculum. The dimensions of the plate were 3 feet 3 inches in diameter, and 3-16ths of an inch thick. It had been placed on a concave cast-iron bed, the edges only of the glass resting on a rim perfectly turned, and fastened in with bees'-wax, which rendered the apparatus air-tight, and was also of a yielding character. By removal of the air from behind the mirror, which Mr. Nasmyth effected with his mouth, sucking it out by a pipe 6 or 8 inches long, the surface of the glass, previously a plane, was pressed by the weight of the external atmosphere considerably out of the level; and by this means the focus of the mirror could be varied to any length. The form which the glass takes is, as it were, a curve of its own making, not exactly a parabola, but more like an ellipsoid. Mr. Nasmyth, however, conceived that the cast-iron back being again turned to an exact figure of any kind, the glass might be made by this simple mode to lie flat on the metal, and again, at pleasure, to resume the plane form. He then named some of the advantages which he thought would result from the use of this contrivance for the specula of reflecting telescopes.

Existence of the Toad without Food.—On September 10, 1836, a living toad was put into the ground, at the depth of eight feet from the surface, in a bed of flinty gravel, with a flower-pot reversed and placed over it. The hole was then filled up and the surface cropped, the spot selected being in a garden. The pit was opened on August 29, 1839, after having been closed three years, save ten days, when the toad was found alive, and used all its exertions to crawl away. It was not a full-grown animal when taken, neither did it appear to have increased in size during its incarceration. This experiment confirms the statements of toads existing without food. In the *Mag. Nat. Hist.* vol. ix, p. 316, is an account of a toad that was immured, by way of experiment, in a block of stone, for the space of thirty-eight years, and at the end of that period was found alive.

Marine Plants.—The plants that grow at the bottom of the sea are found under all climates, because the vicissitudes of heat and cold are never felt at the bottom, the temperature at certain depths being everywhere the same. Climate influences only such as prefer growing in shallow water. A very common sea-plant (*fucus natans*) generally known by the name of sea tang, or sea grass, is universal from the equator to the poles. As there are an immense number of marine plants, a great many of them are to be found everywhere; some, however, seem to require a more concentrated saltness of the water, while others flourish most on a moveable bottom.

Pressure and Rarefaction of the Air.—The pressure of the air, and its rarefaction by heat, are excellently illustrated by the following simple experiment:—Take hold of a wine glass with your right hand, and with your left put into it a small piece of burning paper. When the paper has burned for a few seconds, strike the mouth of the glass against the palm of your left hand, and it will remain firmly fixed to it for a considerable time. The cause of this is, that the internal air is so rarefied by the burning paper, that the pressure upon the inside of the glass is greatly diminished. The equilibrium, therefore, of the pressures upon the outside and inside of the glass being destroyed, the glass must adhere to the hand, till that equilibrium is restored.

Improvement in Drawing Iron and Steel Wire.—The acid liquor used in pickling iron-wire during the drawing of it, requiring to be warmed, at an eminent manufactory, ingots of brass, lying at hand, were accordingly heated red-hot and quenched in the liquor; the consequence of this was, that a portion of the copper in the brass became dissolved in the liquor, and was precipitated upon the surface of the iron wire pickled in it. It was found that the wire thus coated passed through the holes in the plates with remarkable facility, it requiring to be annealed much less frequently than before, owing, no doubt, to the copper preventing the action of the plate upon it, so as to gall or fret it, and, in fact, lubricating it as it were. The head of this manufactory has since constantly availed himself of the use of a weak solution of copper in iron and steel wire drawing. The slight coat of copper is entirely got rid of in the last annealing process.

Relative Strength.—A person, for a short time, is able to use a tool or instrument called

A drawing-knife, with force of .... lbs.	100
An auger, with two hands	100
A screw-driver, one hand	84
A common bench vice handle...............	72
A chisel and awl, vertical pressure	72
A windlass, handle revolving	60
Pincers and pliers, compression	60
A hand-plane, horizontally................	50
A hand or thumb vice....................	45
A hand-saw	36
A stock-bit, revolving	16
Small screw-drivers, or twisting by the thumb and fore-finger only..................	14

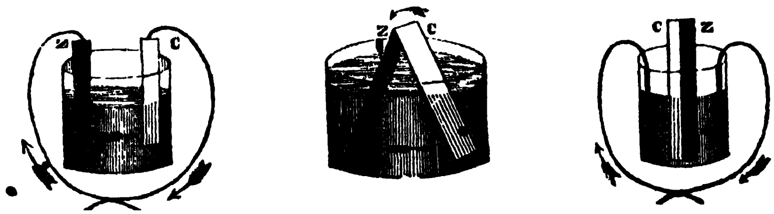
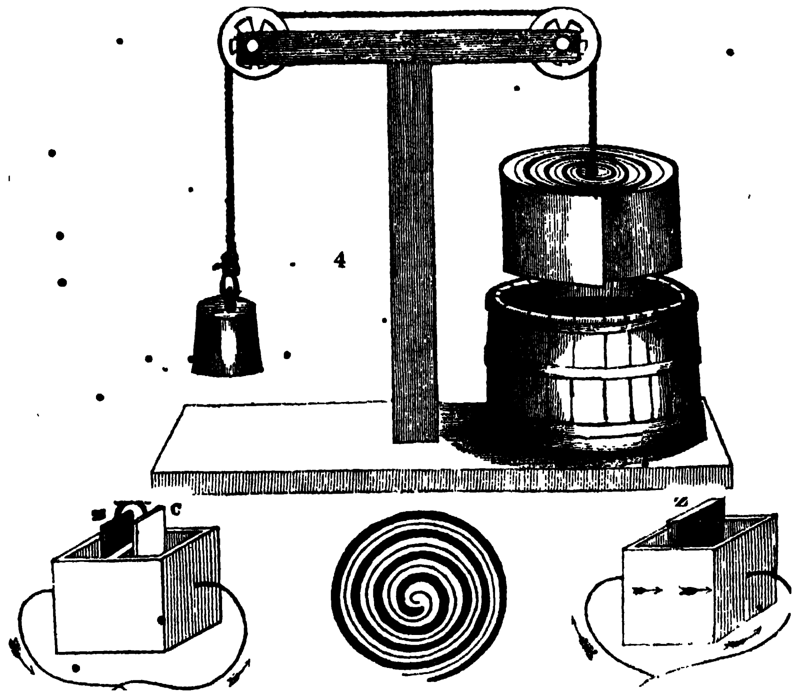


Fig. 1



GALVANISM AND ITS APPARATUS.

The origin of galvanism, or, as it was first called, animal electricity, arose from the accidental circumstance that one of the pupils of Galvani, who was a medical man, was operating upon a dead frog, when another pupil took a spark from an electrical machine close by, and the frog was seen to jump. This being repeated and found to recur each time of trial, excited astonishment and stimulated research. Many experiments were made; among others, the frog was laid upon a copper dish, and being moved about with a knife, it was found that when the one end of the knife touched the plate, and the other end the frog, that the latter jumped without the electrical machine. Thirdly, it was found that the knife or wire which was afterwards used must be of a different kind of metal from the plate, and that the whole must be damp. Then a long series of experiments was instituted, by another person named Volta, as to those metals which would act most energetically together, and as to the liquid which it was best to employ in combination with them. Thus, by a very rapid course of examination and discovery, the principal facts of galvanism were discovered, and the simple experiment of Galvani's pupil became the foundation of an important science. We shall proceed to illustrate some of the principal facts which the labours of Galvani and Volta gave rise to, particularly the construction of the simpler kinds of galvanic apparatus; at present confining ourselves to what are called simple circles, or those kinds of galvanic apparatus which consist of one piece of each sort of metal, with the liquid which keeps them in action.

It is a general principle that galvanic action is always accompanied by chemical action. To disturb the galvanic fluid, therefore, it is only necessary to unite together two metals, and immerse them in a fluid which acts chemically upon one of them, in a different manner from the other, and galvanic disturbance takes place. That such is not always apparent arises from the non-employment of an

instrument delicate enough to detect the quantity of fluid put in agitation.

Ex. 1.—In illustration of this, touch the end of the wet tongue with a shilling, afterwards with a piece of zinc; no flavor will be apparent either time. Hold the two pieces of metal together, and let the edge of both together touch the tongue, and a peculiar acid taste will be immediately perceived. It is because a galvanic circuit is produced, there being two metals and one fluid—the saliva of the mouth.

Ex. 2.—Procure a piece of copper, about 6 inches over, and place upon it a smaller piece of zinc—a piece of damp cloth, not larger then the zinc, being between them. Upon the zinc put a leech, and although there appears nothing to oppose its crawling away, yet it will not pass from the zinc to the copper beneath, because its damp body acts as a conductor to the fluid disturbed, and as soon as it touches the copper plate it receives a shock, and retreats.

Fig. 1 shows one of these simple circles. Z is a slip of zinc. C a similar one of copper. They are partly immersed in dilute sulphuric acid in a glass. While the plates remain without touching each other, no galvanic action is perceptible, zinc is gradually dissolved by the action of the acid, but the copper remains unchanged. Touch these metals together at the top, and the circuit is completed, and a current of the fluid is formed in a certain direction. It passes from the zinc plate through the liquid to the copper, and round at the top where the metals touch, to the zinc again. In this experiment it is seen that the copper received the fluid from the zinc, and communicates it to the zinc again. Thus it is said to be the positive pole, while the zinc parting with its fluid is called the negative pole.

It is quite immaterial whether the two slips of metal communicate directly with each other, or whether wires attached to each are made to touch, as is represented in Fig. 2, where Z and C are the zinc and copper as before, immersed in the same manner, and having wires which complete the circuit. The fluid, as before, passes round the circuit, as represented by the arrows. This apparatus is infinitely more convenient than the last, as it enables the operator to break or complete the circuit at his pleasure, and also every body subjected to experiment is more easily placed within the circuit, or rather is made to form a part of it.

Ex. 3.—This may be exemplified easily by a common phial. Thrust through the cork of a phial two wires or narrow slips, one of copper, the other of zinc, so that they hang parallel to each other, not touching in any part, one end of each being above the cork—the other end below the cork. Partly fill the phial with weak sulphuric acid and water, immerse the lower ends of the wires in it, and observe that the zinc wire only will be acted upon—but touch the two wires at top, and the copper will also become covered with bubbles of gas, and the zinc still more strongly influenced.

Ex. 4.—Immerse an iron knife in a solution of sulphate of copper, (blue-stone,) it will become by chemical action only covered with metallic copper. Immerse also a piece of platinum, without touching the iron, no deposition of copper will take place upon it. Now let the metals be placed in contact with each other at their upper end, and a copious deposit of copper will be seen soon to have settled upon the platinum also.

Ex. 5.—The same may be done with zinc at one pole, and any other metal, or combination of any others for the contrary pole, and upon this depends the whole art of the electro-type. Another modification of the simple galvanic circle is seen in Fig. 3, where the two metals are soldered together, and immersed in the liquid. At some distance are two wires, communicating by their outer extremities with each other. The galvanic fluid, as in every other instance, passes from the zinc through the fluid, then through the wires, till passing through the fluid, again it reaches the copper plate.

It is evident that the effect will be the greater in exact proportion to the size of the plates of metal employed, and that although a small circle produces a comparatively feeble effect, yet it is only necessary to increase the superficies acted upon, to increase also the quantity of the fluid set in motion, Arguing upon this fact, Mr. Hare, of Philadelphia, constructed an immense galvanic circle, formed of zinc and copper plates, which although 60 in number, and therefore may be thought a compound arrangement, were in reality so united together as to form but a single pair of each kind. The effects of this apparatus in heating fluids through which the fluid elicited from it had to pass, and still more so the immense power it possessed in heating and deflagrating metals, occasioned it to be called a *calorimeter*, or a heat mover. A battery of this kind was constructed under the direction of Mr. Pepys, for the Royal Institution. It is represented in Fig, 4, and in section Fig. 5, and consists of two plates of metal only, coiled round each other, each 60 feet long and 2 feet wide, the whole surface being 400 feet. It was charged by being let down into a tub containing dilute acid, and so suspended as to be easily lifted up, when its action was not wished to be continued. Two wires were soldered, one to each sheet of metal, and its effect when these two wires were made to approach each other was astonishingly magnificent and powerful.

A galvanic circle may be formed with the whole surface of the plates being soldered together, as in cut 6, where the zinc and copper are even in different cells, yet the action will be continued although a division is between the metals; and this is, for very many reasons, an extremely advantageous arrangement, particularly if the division plate be porous, that while the direct action is prevented between the two, still as little impediment as possible is given to the passage of the fluid disturbed

A simple voltaic or galvanic circle may be formed of a single metal, and two different fluids, having a different galvanic action upon the metal. Thus suppose a plate of zinc be cemented in a box as in Fig. 7, and salt and water be poured in the cell on one side of it, and acidulated water on the other, an action will take place, and connecting the wires from each cell a current will pass round. The same thing may be effected many ways—it is only by producing an unequal chemical action, thus salt and water alone will succeed, if it be hot on one side of the zinc, and cold on the other; or if the zinc be rough on one side, and smooth on the other. A knowledge of this fact suggested to Mr. Sturgeon the propriety of amalgamating; that is, covering with mercury one surface of the zinc. This he did by merely immersing it for a few minutes in the nitrate of mercury, dipping it in nitric acid, and then rubbing mercury over it.

(*Continued on page 97.*)

VARNISHING

(*Resumed from page 56, and concluded.*)

Mordant Varnish or Gold Size for Gilding.

1 oz. mastic,
1 oz. gum sandarac,
½ oz. gum guttæ,
¼ oz. turpentine, and
6 oz. essence of turpentine.

Some artists who make use of mordant substitute for the turpentine an ounce of the essence of lavender, which renders this composition still less drying.

In general, the composition of mordants admits of much modification, according to the kind of work for which they are destined. The application of them, however, is confined chiefly to gold. When it is required to fill up a design with gold leaf on any ground whatever, the composition which is to serve as the means of union between the metal and the ground ought to be neither too thick nor too fluid; because both these circumstances are equally injurious to delicacy in the strokes. It will be requisite also that the composition should not dry till the artist has completed his design.

Other Mordants. No. 1.—Some prepare their mordants with Jew's pitch and drying oil diluted with essence of turpentine. They employ it for gilding pale gold, or for bronzing.

Other artists imitate the Chinese, and mix with their mordants colors proper for assisting the tone which they are desirous of giving to the gold, such as yellow, red, &c.

Others employ merely fat varnish, to which they add a little red oxide of lead (minium).

Others make use of thick glue, in which they dissolve a little honey. This is what they call *batture*. When they are desirous of heightening the color of the gold, they employ this glue, to which the gold leaf adheres exceedingly well.

No. 2.—The qualities of the following are fit for every kind of application, and particularly to metals. Expose boiled oil to a strong heat in a pan: when a black smoke is disengaged from it, set it on fire, and extinguish it a few moments after by putting on the cover of the pan. Then pour the matter, still warm, into a heated bottle, and add to it a little essence of turpentine. This mordant dries very speedily; it has body and adheres to, and strongly retains gold leaf, when applied to wood, metals and other substances.

Varnish for Pales and coarse Wood-work.—Take any quantity of tar, and grind it with as much Spanish brown as it will bear, without rendering it too thick to be used as a paint or varnish, and then spread it on the pales, or other wood, as soon as convenient, for it quickly hardens by keeping.

This mixture must be laid on the wood to be varnished by a large brush, or house painter's tool; and the work should then be kept as free from dust and insects as possible, till the varnish be thoroughly dry. It will, if laid on smooth wood, have a very good gloss, and is an excellent preservation of it against moisture; on which account, as well as its being cheaper, it is far preferable to painting, not only for pales, but for weather-boarding, and all other kinds of woodwork for grosser purposes. Where the glossy brown color is not liked, the work may be made of a greyish brown, by mixing a small proportion of white lead, or whiting and ivory black, with the Spanish brown.

A Black Varnish for Old Straw or Chip Hats.

½ oz. best black sealing wax, and
2 oz. rectified spirit of wine.

Powder the sealing-wax, and put it with the spirit of wine into a four-ounce phial; digest them in a sand heat, or near a fire, till the wax is dissolved; lay it on warm with a fine soft hair-brush before a fire or in the sun. It gives a good stiffness to old straw hats, and a beautiful gloss, equal to new, and resists wet.

To make Varnish for Colored Drawings

1 oz. Canada balsam, and
2 oz. spirit of turpentine.—Mix them together.

Before this composition is applied, the drawing or print should be sized with a solution of isinglass in water; and, when dry, apply the varnish with a camel's-hair brush.

Another Method.—Dissolve one ounce of the best isinglass in about a pint of water by boiling it over the fire; strain it through fine muslin, and keep it for use.

Try the size on a piece of paper moderately warm, and if it glistens, it is too thick; add more water: if it soaks into the paper, it is too thin; add or diminish the isinglass till it merely dulls the surface; then give your drawing two or three coats, letting it dry between each, being careful (particularly in the first coat) to bear very lightly on the brush (which should be a flat tin camel's hair;) and the size should flow freely from it, otherwise you may damage the drawing.

Then take the best mastic varnish, and with it give at least three coats, and the effect will answer your most sanguine wishes.

This is the method used by many eminent artists, and is found superior to any that has been tried.

Another Varnish for Prints.—Dilute one quarter of a pound of Venice turpentine, with a gill, or thereabouts, of spirits of wine; if too thick, a little more of this last; if not enough, a little more of the former, so that you bring it to the consistence of milk; lay one coat of this on the right side of the print, and, when dry, it will shine like glass. If it be not to your liking, you may lay on another coat.

To make Varnish for Wood, which resists the action of Boiling Water.—Take a pound and a half of linseed-oil, and boil it in a copper vessel, not tinned, holding suspended over it, in a small linen bag, five oz. of litharge, and three oz. of pulverized minium; taking care that the bag does not touch the bottom of the vessel. Continue the ebullition until the oil acquires a deep brown color; throw into the vessel a pound of yellow amber, after having melted it in the following manner:—Add to the pound of amber, well pulverized, two ounces of linseed oil, and place the whole on a strong fire. When the infusion is complete, pour it boiling into the prepared linseed-oil, and continue to leave it boiling for two or three minutes, stirring the whole up well. It is then left to settle; the composition is decantered and preserved, when it becomes cold, in well-corked bottles.

After polishing the wood on which this varnish is to be applied, give to the wood the color required; for instance, for walnut wood, a slight coat of a mixture of soot with the essence of turpentine. When this color is perfectly dry, give it a coat of varnish with a fine sponge, in order to spread it very equally; repeat these coats four times, taking care always to let the preceding coat be dried.

Oil Varnish.—Boil one pint of the best linseed oil, an hour, then add a quarter of a pound of the clearest rosin in powder; stir it well till dissolved; add one ounce of spirits of turpentine; strain it, and bottle for use.

This is a cheap and good varnish for sash frames, or any work where economy is required; it has, besides, the property of bearing hot water without being damaged, and is not subject to scratch.

To Varnish Harps and Dulcimers.—Prepare the work with size and red ochre, then take ochre, burnt umber, and red lead, well ground, and mix up a dark brown color in turpentine varnish, adding as much oil of turpentine that the brush may just be able to pass over the work fair and even. While yet wet, take a muslin sieve, and sift as much Dutch metal, previously powdered, upon it, as is requisite to produce the effect, after which, varnish and polish it.

To Varnish Glass.—Pulverize a quantity of gum adraganth, and let it dissolve for twenty-four hours in the white of eggs well beat up; then rub it gently on the glass with a brush.

To Varnish Balloons. No. 1.—The compositions for varnishing balloons have been variously modified; but, upon the whole, the most approved appears to be the bird-lime varnish of M. Faujas St. Fond, prepared after M. Cavallo's method as follows:—"In order to render linseed oil drying, boil it with 2 ounces of sugar of lead, and 3 ounces of litharge, for every pint of oil, till they are dissolved, which may be in half an hour. Then put a pound of bird-lime, and half a pint of the drying oil, into an iron or copper vessel, whose capacity should equal about a gallon, and let it boil very gently over a slow charcoal fire, till the bird-lime ceases to crackle, which will be in about half, or three quarters of an hour; then pour upon it two and a half pints more of the drying oil, and let it boil about an hour longer; stirring it frequently with an iron or wooden spatula. As the varnish, whilst boiling, and especially when nearly ready, swells very much, care should be taken to remove, in those cases, the pot from the fire, and to replace it when the varnish subsides; otherwise it will boil over. Whilst the stuff is boiling, the operator should occasionally examine whether it has boiled enough, which may be known by observing whether, when rubbed between two knives, which are then to be separated from one another, the varnish forms threads between them, as it must then be removed from the fire. When nearly cool, add about an equal quantity of oil of turpentine. In using the varnish, the stuff must be stretched, and the varnish applied lukewarm. In 24 hours it will dry."

No. 2.—As the elastic resin, known by the name of Indian rubber, has been much extolled for a varnish, the following method of making it, as practised by M. Blanchard, may not prove unacceptable:—Dissolve elastic gum, cut small, in five times its weight of rectified essential oil of turpentine, by keeping them some days together: then boil 1 ounce of this solution in 8 ounces of drying linseed oil for a few minutes; strain the solution, and use it warm.

To Varnish Rarefied Air Balloons.—With regard to the rarefied-air machines, M. Cavallo recommends, first, to soak the cloth in a solution of sal-ammoniac and common size, using one pound of each to every gallon of water; and when the cloth is quite dry, to paint it over on the inside with some earthy color, and strong size or glue. When this paint has dried perfectly, it will then be proper to cover it with oily varnish, which might dry before it could penetrate quite through the cloth. Simple drying linseed oil will answer the purpose as well as any, provided it be not very fluid.

To Polish Varnish.—This is effected with pumice-stone and Tripoli earth. The pumice-stone must be reduced to an impalpable powder, and put upon a piece of serge moistened with water; with this rub lightly and equally the varnished substance. The tripoli must also be reduced to a very fine powder, and put upon a clean woollen cloth, moistened with olive oil, with which the polishing is to be performed. The varnish is then to be wiped off with soft linen, and when quite dry, cleaned with starch or Spanish white, and rubbed with the palm of the hand.

Colors proper for Colored Varnishes.—Blacks.—Lamp-black, carefully washed and afterwards dried; or black obtained from burnt vine twigs, or peach-stones.

Yellows.—Yellow ochre, yellow pink, Naples and Montpelier yellows. In mixing up the last two, a horn or ivory spatula, with a glass pestle and mortar must be used, because these yellows are hurt if touched with steel or iron.

Blues.—Indigo, Prussian blue, blue verditer, and ultra marine. All these must be very finely powdered.

Greens.—Verdigris, distilled or crystallized verdigris, and green compounded of yellow and blue. The verdigrises will require a mixture of white, varying from one fourth to two-thirds, according to the tint intended to be given. Either white lead, Spanish white, or ceruse may be used for this purpose.

Reds.—Vermillion, red lead, red ochre.

Purples.—Cochineal, carmine, and carminated lakes with ceruse and boiled oil.

Brick Red.—Dragon's blood.

Buff.—Dragon's blood, with a little vermillion.

Violet.—Red lead, mixed with lamp black, with a slight mixture of blue and white.

Pearl Grey.—Ceruse mixed with lamp-black; or ceruse mixed with indigo.

Flaxen Grey.—Ceruse mixed with carminated lake, and a very small quantity of Prussian blue.

MAKING THE NAPOLEON MEDALS.

(En Cliché.)

Our readers must have frequently seen the beautiful impressions, or medallions, struck from the Revolutionary, Napoleon and other medals during the wars with France, and which were usually bronzed, mounted into the lids of snuff-boxes, and defended from injury by being covered with convex glasses.

It is a fact, that either from a medal struck in any of the usual metals; from a *soft* steel die, or even from one of these medallions themselves, dies may be readily made, each of which will be capable of striking a considerable number of such medallions, and each of these in its turn be capable of producing a multitude of other dies, likewise fit to become the origin of as many successive medallions and dies; so that by this means, the original medal may be copied almost *ad infinitum!* Each remove from the original, however, losing of course some-

thing of its sharpness and accuracy of finish, although much less than might be supposed, and greatly less than by the usual methods of copying medals, by moulding and casting them.

We cannot but be surprised that so valuable an art should hitherto, in this country, have remained in so few hands; as, from the succeeding details, it will be found to be abundantly simple and easy to execute.

Of the Metal used in forming the Dies and the Medallions.—This metal is composed of the ordinary *type metal*, which is an alloy of lead and regulus of antimony, to which is added more and more lead, until on trial, by repeatedly breaking a plate cast from the mixture, it is found to bend a little before breaking. This is one of the best criterions to judge by, as from the variety of proportions of lead and regulus employed by different type-founders, no certain proportions can be ascertained in the composition of the *broken types*, which are purchased for this use

This compound metal is made and melted in a cast-iron pot, such as is used in cooking, and which is suspended over the fire by its bail or handle. The alloy, when a small quantity of it is taken up in an iron ladle, and kept in continual motion by shaking the ladle round and round whilst it is cooling, at length assumes a *pasty consistence*, or a commencement of crystallization: this is the proper moment for employing it either to form a die or a medallion, by striking the original medal or medallion, or a die upon it, in the manner to be hereafter described; when, from its pasty coherence, it cannot slip away from the blow, and is yet sufficiently plastic to receive the impression of the medal or die.

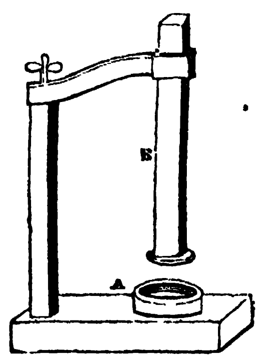
The compound metal at the above period does not retain heat enough to singe, or even to discolor the paper upon which it is laid to receive the impression; and this again forms another valuable criterion to judge by, whether the alloy is rightly proportioned or not.

It would hardly be thought that this alloy or composition should be capable both of forming the die or mould, and of yielding also numerous impressions from it, and yet such is the fact: a most remarkable discovery, and one, indeed, upon which the great merit of the art chiefly rests.

Type metal may consist of about five parts of lead and one of regulus of antimony. The lead being melted in an iron vessel, the regulus must be stirred in it continually, and be kept immersed in the lead, until it is at length dissolved or melted in it: this, however, is a work of time, and very much depends upon the *due heat* given to the lead, which ought to be above its melting point, though not much, lest it greatly oxidate it. The surface of the lead ought also to be covered with rosin, pitch, or grease, to prevent such oxidation as much as possible. Very much of the goodness of the type metal depends upon the quality of the regulus which enters its composition. As, for instance, if it contains more or less *iron* or tin (the clippings of tinned iron plates being generally preferred in this country for making the regulus from the ores of antimony,) or *copper*, which is particularly recommended for making a *whiter pewter*, than the regulus made with iron, or being nearly free from any admixture with either of those metals, and which is the case with a very superior kind of regulus we have seen recently; so that the nature of the type metal, as we have before said, is infinitely various.

These impressions are also taken by the French in what they term "*Darcet's alloy*," but which we know under the name of *Sir Isaac Newton's fusible metal*, being a compound of three parts of tin, five of lead, and eight of bismuth, and capable of melting in boiling water. This metal, although more expensive, is harder than that above described, and is capable of giving exceedingly sharp impressions. A still better metal would, however, be *G. Smith's solder for tin*, as it is not so liable to crystallize in cooling as the fusible metal. This is composed of one part of each of lead and tin, and two parts of bismuth.

Apparatus employed.—The machines used in striking these medallions are various; the common screw press will answer this purpose tolerably well, though the gradual pressure which it gives is not to be compared to the effect of a sudden blow. Another method, and one which we have tried with perfect success, is to pour the metal on a thick felting of leather or paper; when it begins to cool, so as to be scarcely fluid, place the copy upon it, rest a flat-ended stick upon it, and give the top end of the stick a sudden blow. The following figure shows a neater contrivance for the same purpose; it represents a stand with an upright bent arm, through a square hole in the top of which passes a square solid rod B. The metal is poured into the metal cup A, and, when at the right degree of heat, the rod B, which has the medal fastened with a bit of wax to the lower end, is to be let down, and a sudden blow to be given to the top, when the force will cause the impression to be a good one, if carefully performed. After the medallions are struck, the backs of them are turned flat and the edges turned evenly round in a lathe adapted to the purpose.



On Bronzing the Medallions.—To perfectly succeed in bronzing these medallions we must employ the two following solutions; the first, which serves as a preparatory wash, to be used as hereafter described, is composed of one part of sulphate of iron, one part of sulphate of copper, and twenty parts (by weight) of distilled water.

The second solution, which is the bronze, is less complicated; it is composed of four parts of verdigris, and sixteen parts (by weight) of white French vinegar.

The manner of employing these Solutions.—When the medallions have been filed and polished on their edges, and strongly rubbed with a brush, wetted with a mixture of tripoli, or rotten-stone

and water, and well washed and dried, we pass the first solution slightly over both their faces, with a hair pencil, and then wash and wipe the medallion dry; this gives them a slightly blackish color, and causes the verdigris to adhere more quickly to them. They are then rubbed with another hair-pencil, wetted with the second solution, until they become of a deep copper color; they are then left to dry for an hour, after which they are polished with a soft brush and red lead, breathing upon them frequently, to slightly moisten them, and cause the red lead to adhere to them; the polish is lastly finished with a soft brush alone, passing the brush from time to time over the palm of the hand. To prevent the bronzes from being attacked by humidity, they may be covered with a slight coat of gold colored lacquer.

The *clichès* made with Darcet's alloy, fusible metal, are bronzed with the second solution only, and do not require to be varnished to preserve them from the effects of humidity.

The plumbers give their soft soldered joints near the cocks the appearance of copper, by wiping over them a mixture of sulphate of copper in powder, with vinegar.

The above medallions are frequently bronzed by coating them with a thin layer of gold size, and then applying bronze powder with a dry hair pencil, in the usual manner of bronzing plaster figures, &c.

WOODEN MARBLES.

A French gentleman, M. C. Malo, has discovered the secret of imitating, by means of a peculiar wooden paste (without any inlaid work or incrustation), the most precious and rare sorts of natural marbles, and creating, according to the dictates of fancy or imagination, such different sorts of marble as nature does not produce.

Up to this period, marble could only be obtained from nature, but in future, by the use of this invention, the richest and rarest marbles can be produced, with those thousand accidental fissures, veins, shades, and transparencies, &c., which the ablest painter can but imitate *on the surface*, with great expense, and after all, insufficient in its execution as well as in result. The patent marbles can be made of any size or *thickness*, and with a charming perfection.

The substance of this composition is of the greatest solidity, and does not want any re-touching or amelioration for many years. It can be washed and cleaned with an ordinary sponge. In case of accident, or many years wear, it can be scaled and renewed in the same way as common wood. The shavings thus taken off will show every vein of marble thus imitated, leaving the underpart with all the veins, shades, and polish entire, and without, in any way, injuring the finish or beauty of the workmanship.

This discovery opens an immense field in England to all the manufacturers of cabinet work, ornamental architecture, and, in fact, not only wherever marble can be used this imitation can be adopted; but it can be made use of in the manufacture of the smallest articles, as well as in objects of the greatest dimensions.

Wherever the most magnificent marble may be required it may be produced with veins of gold, silver, mother-of-pearl, and, indeed, it can be enriched with all the wonders of the mineral world.

SPONTANEOUS COMBUSTION.

Many vegetable substances, highly dried and heaped together, will heat, scorch, and at last burst into flame. Of these, the most remarkable is a mixture of the expressed oil of the farinaceous seeds, as rape, or linseed oil, with almost any dry vegetable fibre, such as hemp, cotton, matting, &c., and still more so, if also united with lamp-black, or any other carbonaceous substance. These mixtures, if kept for a time undisturbed in close bundles, and in a warm temperature, even in small quantities, will often heat, and burn with a smothered fire for some hours: and if air be admitted freely will then burst into flame. To this, without doubt, may be attributed several accidental conflagrations in storehouses, and places where quantities of these substances are kept. Indeed this has been proved by many experiments. The most important of these were made by Mr. George, and a Committee of the Royal Academy at Petersburgh, in the year 1781, in consequence of the destruction, by fire, of a frigate in the harbour of Cronstadt; the conflagration of a large hemp magazine, in the same place in the same year; and a slight fire on board another frigate, in the same port in the following year.

These accidents led to a very strict examination of the subject by the Russian government; when it came out, that at the time of the second accident, several parcels of matting, tied with pack-thread, in which the soot of burnt fir-wood had been mixed with oil, for painting the ship, had been lying some time on the floor of the cabin, whence the fire broke out. In consequence of this important discovery, forty pounds of fir-wood soot were well soaked in about thirty-five pounds of hemp oil varnish, and the whole was wrapped up in a mat, and put in a close cabin. In about sixteen hours it was observed to give out a smoke, which rapidly increased, and when the door was opened, and the air freely admitted, the whole burst into a flame. Three pounds of fir-black were mixed with five pounds of hemp oil varnish, and the whole bound up in linen, and shut up in a chest. In sixteen hours, it emitted a very nauseous putrid smell and steam; and two hours afterwards it was actually on fire, and burnt to ashes.

In another experiment the same occurrences took place, but not till forty-one hours after the mixture had been made; and in these and many similar experiments they all succeeded better, and kindled sooner, in dry than in rainy weather. Chimney soot used instead of lamp-black did not answer, nor was any effect produced when oil of turpentine was substituted for the hemp or rape oil. In general, it was found, that the combination took place more readily with the coarser and more unctuous fir-black, than with the finer sorts; but the proportions of the black to the oil did not appear to be of any great moment. Sometimes, in wet weather, these mixtures only became hot for some hours, and then cooled again, without actually taking fire.

In all these cases, the soot or black, was from wood, and not coal. The presence of lamp-black, or any other dry carbonaceous matter, is not necessary however; for spontaneous inflammation will take place in hemp or cotton, simply soaked in any of these expressed oils, when in considerable quantity, or under circumstances favorable to this process; as in hot weather, or when closely shut up. An accident of this sort happened at

Gainsborough, in Lincolnshire, in July, 1794, with a bale of yarn of 120lb, accidentally soaked in rape oil; which, after remaining in a warehouse for several days, began to smoke, to emit a most nauseous smell, and finally to burst out into a most violent flame. A similar accident with a small quantity of the same materials happened at Bombay. A bottle of linseed oil had been left standing on a chest; this had been thrown down by accident in the night, the oil ran into a chest which contained some coarse cotton cloth, and in the morning the cloth was found scorching hot, and reduced nearly to tinder, the wood of the chest also was charred on the inside. On subsequent trial, a piece of the same cloth was soaked in oil, it was scorching hot; and on opening the cloth it burst into flame.

Similar to this is the spontaneous combustion of wool, or woollen yarn, which has occasionally happened when large quantities have been kept heaped up in rooms little aired, and in hot weather. The oil with which wool is dressed, which is generally rape oil, appears the chief agent in this combustion. Even high dried oily or farinaceous matter, of any kind, will alone take fire when placed in circumstances favorable to this process. Rye flour roasted till half parched, and of the color of coffee, and wrapped up in a linen cloth, has been found to heat violently, and to destroy the cloth. Wheat flour, when heated in large quantities, and highly dried, has been known to take fire in hot weather, causing accidents in granaries and bakers' shops. An accident of this kind is related by Count Morrozzo, in the Memoirs of the Turin Academy, to have happened at a flour warehouse at Turin, containing about three hundred sacks of flour. It began by a violent explosion, on a lamp being brought into the warehouse, and the whole was soon after in flames. Charcoal alone also has been known to take fire in powder mills, when quantities of it in powder have been kept for some time closely packed.

Another, and totally different species of spontaneous combustion, is that which occurs during the oxygenation or vitriolization of pyrites, or sulphurets of iron, copper, &c.

A most curious and, if not well authenticated, a scarcely credible species of spontaneous inflammation, is that, in a few rare instances, known to occur in the human body. It is not quite certain indeed whether the first inflammation has been quite spontaneous, or caused by the approach of a lighted substance; but in these melancholy accidents, the body of the unfortunate sufferer has been brought to a state of such high combustibility, that the flame once kindled has gone on without other fuel, to the entire destruction of every part, (the bones and extremities excepted,) and as it appears has been attended with actual flame, of a lambent faint light. This change is the more remarkable, as the human body, in all its usual states, both of health and disease, is scarcely at all of itself combustible, and cannot be reduced to ashes without the assistance of a very large pile of faggots, or other fuel; as universal experience, in the very ancient mode of sepulture, and the history of martyrdoms, abundantly shows. Cases of this human combustion on record have occurred in different countries. Two of them, well authenticated, are recorded in the "Philosophical Transactions," and occured in England; and a few others in Italy, France, and elsewhere. In all but one, the subjects of them have been females rather advanced in life, of indolent habits, and apparently much addcated to spirituous liquors.

The accident has generally been detected by a penetrating fetid smell of burning, and sooty films, which have spread to a great distance; and the sufferers have in every instance been discovered dead, and with the body more or less completely burnt up, leaving in the burnt parts only an oily, crumbly, sooty, and extremely fetid matter. Another circumstance, in which all these cases agree, is the comparative weakness of the heat produced by this combustion, notwithstanding the very complete disorganization of the body itself, so that the furniture of the room, wooden chairs, &c., found within the reach of the burning body, were in many instances absolutely unhurt, and in others only scorched; the heat not having been strong enough to set them on fire. It is impossible to give an adequate reason for this remarkable change; nor does it seem before the very time of the accident to have produced any very sensible alteration in the appearance and functions of the body, which is certainly a most astonishing circumstance. With regard to the effect which the use of ardent spirits is supposed to have in this case, it is impossible not to imagine that this cause may contribute largely to such a change; but the instances of the abuse of spirits are so innumerable, and those of this surprising combustion are so extremely rare, that very little satisfaction can be obtained from this explanation.

Hydrogen gas enters largely into all animal, vegetable, and many mineral compositions. Hence it is frequently set at liberty by fermentation or spontaneous decomposition in bogs and marshes; when free from electricity or some other accidental cause it is often set on fire. This phenomenon has been observed in almost all parts of the world. In Persia it is converted into a *pious fraud* by the priesthood, who by means of hollowed reeds convey the carburetted hydrogen gas into one of their temples, which has been purposely built upon ground abounding in bitumen, naphtha, and other inflammable substances. As the Persians have always been worshippers of fire, the imposition is a happy one, for in this temple they are continually feasted with a view of their Deity.

At Moulton, near Northampton, in the forenoon of September 11th, 1810, a fire broke out in an ash-spinney. Mr. Marsh, the proprietor, immediately went to the spot with some friends, and found the *fire issuing from the earth* in many places, and in a short time it would have communicated to a gorse cover, had it not been for the timely assistance of several persons whom curiosity had brought to witness this extraordinary phenomenon. As there was some lightning during the morning, it was imagined a fire-ball had been the cause, but it was generally supposed to be occasioned by the excessive dryness of the ground, which had been a bog, recently drained for planting; and that the extreme heat of the sun had caused it to ignite.

STAINING WOOD, &c.

STAINING wood is altogether a different process from dyeing it, and requires no preparation before the stain be applied: it is peculiarly useful to bedstead and chair makers. In preparing the stain but little trouble is required; and, generally speaking,

its application differs very little from that of painting. When carefully done, and properly varnished, staining has a very beautiful appearance, and is much less likely to meet with injury than japanning.

Black Stain for immediate use.—Boil half a pound of chip logwood, in two quarts of water, add one ounce of pearl-ash, and apply it hot to the work with a brush. Then take half a pound of logwood, boil it as before in two quarts of water, and add half an ounce of verdigris and half an ounce of copperas; strain it off, put in half a pound of rusty steel filings; with this go over your work a second time.

To stain Beech a Mahogany Color.—Put two ounces of dragon's blood, broken in pieces, into a quart of rectified spirits of wine; let the bottle stand in a warm place, shake it frequently; when dissolved, it is fit for use.

Another Method for a Black Stain.—Boil one pound of logwood in four quarts of water, add a double handful of walnut-peel or shells; boil it up again, take out the chips, add a pint of the best vinegar, and it will be fit for use; apply boiling. This will be improved, if, when dry, you apply a solution of green copperas as dissolved in water, (an ounce to a quart) hot over your first stain.

To imitate Rosewood.—Boil half a pound of logwood in three pints of water, till it is of a very dark red, add half an ounce of salt of tartar. While boiling hot, stain your wood with two or three coats, taking care that it is nearly dry between each; then with a stiff flat brush, such as is used by the painters for graining, form streaks with the black stain above-named, which, if carefully executed, will be very nearly the appearance of dark rosewood.

Another Method.—Stain with the black stain; and when dry, with a brush as above, dipped in the brightening liquid, form red veins, in imitation of the grain of rosewood, producing a beautiful effect. A handy brush for the purpose may be made out of a flat brush, such as is used for varnishing; cut the sharp points off, and make the edges irregular, by cutting out a few hairs here and there, and you will have a tool which will actually imitate the grain.

To imitate King or Botany-bay Wood.—Boil half a pound of French berries, in two quarts of water, till of a deep yellow, and, while boiling hot, give two or three coats to your work; when nearly dry, form the grain with the black stain, which must also be used hot. You may, for variety, to heighten the color, after giving it two or three coats of yellow, give one of strong logwood liquor, and then use the black stain as directed.

Red Stain for Bedsteads and Common Chairs.—Archil, as sold at the shops, will produce a very good stain of itself, when used cold; but if, after one or two coats, being applied and suffered to get almost dry, it is brushed over with a hot solution of pearl-ash in water, it will improve the color.

To improve the Color of any Stain.—Mix in a bottle one ounce of nitric acid, half a tea-spoonful of muriatic acid, a quarter of an ounce of grain tin, and two ounces of rain-water. Mix it at least two days before using, and keep your bottle well corked.

To Stain Horn in Imitation of Tortoise-shell.—Mix an equal quantity of quick-lime and red lead with strong soap-lees, lay it on the horn with a small brush, in imitation of the mottle of tortoise-shell; when dry, repeat it two or three times.

MISCELLANIES.

Errors in Natural History.—The stories that there is but one phœnix in the world, which, after many hundred years, burns herself, and from her ashes rises another; that the pelican pierces her breast with her beak to draw blood for her young; that the cameleon lives only upon air; of the bird of Paradise, and of the unicorn, are all fabulous.

It is an error to suppose that the scorpion stings itself when surrounded by fire, and that music has power over persons bitten by it; that the mole has no eyes, and the elephant no knees; that the hedgehog is a mischievous animal, particularly that he sucks cows when they are asleep, and causes their teats to be sore.

It is said that the porcupine shoots out its quills to annoy its enemy, whereas it only sheds them annually, as other feathered animals do. The jackall is commonly called the lion's provider, but it has no connexion with the lion. The bite of the spider is not venomous; it is found, too, in Ireland plentifully—has no dislike to fixing its web on Irish oak, and has no particular aversion to a toad.

The ass was vulgarly thought to have had a cross on its back ever since Christ rode on one of those animals. It was also believed, that the haddock had the mark of St. Peter's thumb ever since St. Peter took the tribute penny out of a fish of that species.

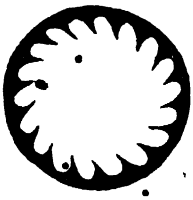
It was anciently believed, says Brand, that the barnacle, a common shell-fish, which is found sticking on the bottom of ships, would, when broken off, become a species of goose. Nor is it less an error, that bears form their cubs by licking them into shape; or that storks will only live in republics and free states.

"The Rose of Jericho," which was feigned to flourish every year about Christmas Eve, is famous in the annals of credulity; but, like the no less celebrated "Glastonbury Thorn," is only a monkish imposture.

It is commonly believed, and even proverbial, that puppies see in nine days; but the fact is, they do not see till the twelfth or fourteenth.

Beautifying Agates.—Dealers in gems have a secret method of producing, artificially, some beautiful effects in agates, which, to the eye, have all the appearance of being natural, and being insisted on as such, serve at times to cheat the amateur out of very high prices. These effects are supposed to be obtained by a succession of blows, adroitly struck on the stone, previous to its being polished. The means of detecting the artifice, taking it for granted that such is the mode of operation, are sufficiently simple. Every blow must have produced, under the place where it was given, the figure of a regular cone, with its base next to the point of contact. Traces of this figure may sometimes be discerned by the naked eye in the polished stone, and always with the aid of a microscope. To make quite sure of their having been artifically produced, wet the stone, when the traces will be found almost entirely to disappear, on account of the liquid penetrating the fissures, and afterwards to re-appear on the stone becoming dry.

A Test of Silver.—Silver, in its native or virgin state, has a great external likeness to tin, but may on examination be easily distinguished from that metal by its being much heavier, and by its remaining unaltered under the operation of fire, whereas tin burns entirely away under a continued heat.



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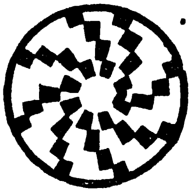

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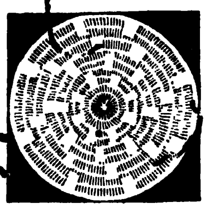

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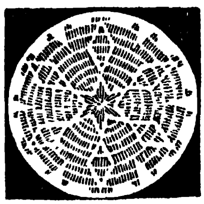

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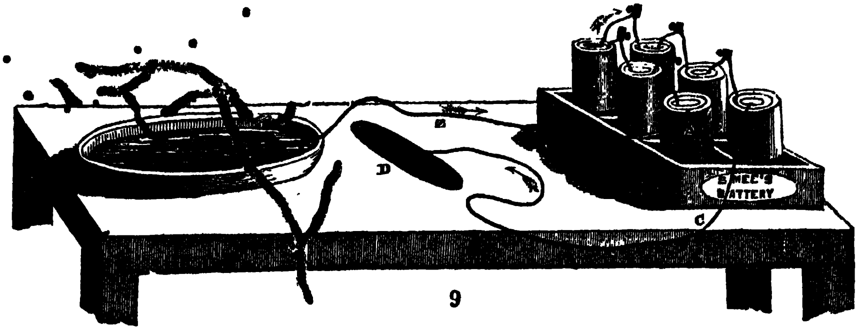
METALLOCHROMY, AND SMEE'S GALVANIC BATTERY.



9

METALLOCHROMY, AND SMEE'S GAVANIC BATTERY.

Metallochromy is, as the name implies, an art by which various colored rings and devices are formed upon the surface of metallic plates. It depends for its effect upon galvanism, and is but another of the daily occurring instances of the benefits that are likely eventually to ensue from this curious and valuable science.

The art in question may be made subservient to the permanent and tasteful decoration of most of the numerous steel articles which our manufactories so extensively produce—while the process is so simple that error or failure is impossible—the variety of ornament so great, that it may be considered endless—the cost so small, that it cannot be appreciated, and the effect so different from all other decorations, that it cannot be imitated but by the same means.

The whole of the art depends upon a simple galvanic experiment. The materials and apparatus required, are a galvanic battery of some kind, of six or more pair of elements. It is immaterial of what description this battery is; any of the old fashioned ones will do as well as those of modern date, the two wires to connect the poles, a bright steel plate, or other bright steel surface; a dish capable of holding the plate; a round, flat, or very slightly concave piece of copper 3 or 4 inches over, some subacetate or sugar of lead; and some sulphuric acid; being thus furnished, set to work as follows.

Ex. 1.—Dissolve the sugar of lead in distilled water, so as to make a saturated solution; if you have no distilled water, you will most probably have a turbid solution; whenever this is the case, it must be filtered through blotting paper until quite clear. Put the steel plate in the dish, and pour over it the solution, and underneath, in connexion with it, the wire from the negative end of the battery. Then charge the battery with the acid made weak with water. Then immerse the point of the positive wire, and hold it at a short distance above the centre of the steel plate, when in a second or two a beautiful colored ring will observable around it; continuing to hold it thus, the ring will change color, from red to blue or yellow, and will increase in size, while a second, and momentarily afterwards a third, fourth, and fifth will be found within it, radiating in a most beautiful manner.

Ex. 2.—The steel plate may be thus marked much more expeditiously by using the copper disc formerly spoken of—this connected with the positive wire, and held as the point had been, the whole surface will become at once colored—that is, within a quarter of a minute, or less if the battery be strong. A different degree of intensity as well as a different range of colors may be produced according as the disc may be flat, concave, or convex—though in every instance the concavity should be very slight.

Ex 3.—To hold the positive wire sufficiently steady is a matter of difficulty—a better method is to interpose a card or piece of paste-board, by putting this upon the steel plate, and then the copper disc upon it. The card, being a non-conductor, will not interfere with the effect intended to be produced. It is necessary, however, that whenever a configuration is to be made, the card should be cut away. For example, a film of card may be made as in Fig. 1—the design will therefore appear as in Fig. 5, no color being seen beyond the open space left in the card.

This fact tends much to variety, and enables us to apply the principle to the figuring of innumerable objects; a button, for instance, may have a red, blue, or other colored star, impressed upon it, by merely cutting out such a figure in the card which is placed upon it. A shield or cypher letters may be made in the same manner, with equal facility. We have endeavoured to show two or three patterns of this description in Figures 2, 3, and 4; and have given an idea of the effect in Figs. 6, 7, and 8; though, it must be admitted that these convey a very imperfect notion of the exquisitely beautiful forms which this simple apparatus is capable of producing. Figure 9, shows the whole of the apparatus requisite, and the method of its arrangement in performing this experiment. The battery shown at A is that of Mr. Smee, described in page 22. B is the plate of metal. C is the positive wire. D is the disc of copper, and Z the negative wire which is connected with B.

HORTUS SICCUS.

OR PREPARATION OF SPECIMENS OF PLANTS.

(Resumed from page 52, and concluded.)

In addition to the methods of preparing a Hortus-siccus already pointed out, I am desired by my friend Mr. Whately, Surgeon, in London, to insert the following account of a method which he has used with the greatest advantage; and such of my readers as observe his rules, and execute them with adroitness, will find their attentions well rewarded.

"Previously to the drying of plants by this plan, it will be necessary to procure the following apparatus:—

"1. A strong oak box of the size and shape of those used for the packing up of tin plates.

"2. A quantity of fine and dry sand of any kind, sufficient to fill the box.

"3. A considerable number of pieces of pliant paper, from one to four inches square.

"4. Some small flat leaden weights, and a few small bound books.

"The specimen of any plant intended for the Herbarium, should be carefully collected when dry. and in the height of its flowering, with the different parts as perfect as possible, and in the smaller plants the roots should be taken up. It should then be brought home [illegible] closed from the air. The plant [illegible] be [illegible] from the decayed leaves [illegible], and afterwards laid upon the inside of one of the leaves of a sheet of common cap paper. The upper leaves and flowers should then be covered in an expanded state by pieces of the prepared paper, which may be placed in any irregular way, and kept down by the fingers till these parts of the plant are entirely covered by them; and after that, let one or two of the leaden weights be placed upon the papers. The parts of the plant below should then be covered with the pieces of paper, and likewise with the weights, and thus the whole plant should be laid in its proper expanded form by the same method. The weights should then be carefully removed, and the other leaf of the sheet of paper applied to its opposite one, having the loose pieces of paper and plant between them. After which, one or two of the books should be placed on the outside of the paper, and remain there till as many other plants as are

intended to be preserved, have been prepared in like manner. A layer of sand an inch deep should then be put into the box, and afterwards one of the plants, with the books placed upon it, which last should be removed after a sufficient quantity of sand is put upon the paper, to prevent the plant from varying its form. All the other plants may then be put into the box in the same manner, with a layer of sand about an inch thick between each, when the sand should be gently pressed down by the foot, and the degree of pressure, in some measure, regulated by the kind of plants in the box. If they are stiff and firm, as the holly or furze, much pressure is required. If tender and succulent, a lesser degree is better, for fear of extravasating the juices, which would injure the color of the plant; but particular care should be taken to make a sufficient degree of pressure upon the expanded blossoms of plants, that they may not shrivel in drying. The box should then be carefully placed before a fire, with one side a little raised or occasionally flat, as may be most convenient, alternately changing the sides of the box to the fire, twice or thrice a day; or, when convenient, it may be put into an oven in a gentle heat. In two or three days the plants will be perfectly dry. The sand should then be taken out with a common plate, and put into a square box, and the plants carefully taken out also, and removed to a sheet of writing-paper.

"This method of preserving plants is, from much experience, found preferable to any other, and has every advantage attending it that can be wished; it dries most of them of an exceedingly fine natural and durable color, as well in the flowers as leaves. It will be found upon trial, that a different degree of heat is suitable to different plants, the exact knowledge of which will be easily acquired by a little experience, and that some will dry much better than others. I have always found the fewer plants there were in the sand at a time, and the quicker the heat, the better the colors were. Those plants that have colored flowers should be placed uppermost, otherwise their colors will be injured by the slow dissipation of the moisture from the others.

"Plants are most fit for future examination when preserved loose within the paper, and if they are kept in a very dry room and unexposed to the air, they will preserve their beauty a great number of years; but it will be necessary to inspect them once a year, to destroy any of the small insects that may breed amongst them, and this will be fully sufficient for their preservation."

By whatever method the plants are dried, the precautions mentioned in the last paragraph of Mr. Whately's account, are indispensable to their preservation. They may be most conveniently kept in a cabinet made for the purpose, with the drawers open in front, excepting only a shallow edge at the bottom of each—placing the species of each genus together, and keeping each class separate.

Withering's Botany.

ON GRINDING AND POLISHING LENSES.

The first thing is to fix upon the proper aperture, or breadth, and focal distance of the glass: a piece of sheet copper is then taken, and, with compasses opened to the focal distance, supposing the glass is intended to be convex on both sides, and two arches, each a little larger than the intended breadth of the glass, are then struck; but if the glass is to be flat on one side, the compasses are only to be opened to half the distance of the focus.

The copper is then filed away from the outside of one of these arches, and from the inside of the other, by which means two guages are formed—the one convex, and the other concave.

Two circular plates of brass, half an inch broader than the intended glasses, and about a tenth of an inch in thickness, are then taken, and these plates are soldered upon a cylinder of lead of the same diameter, about an inch high. One of these tools, as they are called, is fixed upon a turning-lathe, and turned so as to correspond with one of the guages, and the other to correspond with the other guage. The two tools are then to be ground together with the finest flour emery, until the surfaces exactly coincide. If the focal distance is very short, the plates, before they are soldered upon the lead, should be hammered, as truly as they can be done, into the proper form.

If the lens is not for achromatic instruments, glass of a straw color, whose dispersive power is as small as possible, is chosen, which has the two surfaces parallel; and, by means of scissors or pincers, it is cut into a circle, the edge smoothed by a common grindstone, and it is fixed by means of pitch to a wooden handle of less diameter than the glass, and about an inch high, so that the centre of the handle may exactly coincide with the centre of the glass. If the intended focal distance is very small, the surface of the glass is ground on the grindstone, so as to suit the guage as far as possible.

The glass being thus prepared, and supposing the lens intended to be convex, which is the most common form, it is then ground with fine emery upon the concave tool, which is to be firmly fixed to a table or bench, and the glass wrought upon it with circular strokes, so that its centre may never pass beyond the edges of the tool. After every circular turn, two or three cross turns along the diameter of the tool, in different directions are given.

When the glass has got into its proper shape, and touches the tool in every part of its surface, which may easily be known by inspection, the emery is to be washed away, and finer kinds substituted, until all the scratches and roughnesses are worn down. Those that remain after the finest emery has been used, are taken away, and even a slight polish given to the glass, by grinding it with pounded pumice-stone. During all this operation of grinding, the convex tool, at the end of every five minutes, is ground for a few seconds upon the concave tool, in order to preserve the proper curvature. The glass is then separated from the handle by a knife, the pitch removed by rubbing it with a little oil, the already ground side fixed upon the handle, and the other side ground and finished in the same manner.

To form concave glasses, the convex tool is used in the same manner as the concave tool is used for convex glasses.

Some persons, for concave glasses, use leaden wheels, having the same radius as the curvature of the glass, and with their circumference of the same convexity as the glass is to be concave. These wheels being fixed upon a lathe, the glass is held steadily in the hand, and ground upon them with emery. For common purposes, convex glasses are ground by fixing the concave tool upon the lathe, and applying in the same manner the glass to it.

But this manner of grinding will not do for glasses when they are to be employed in the best kind of optical instruments.

When the glass is brought by these methods to the proper form, the next and by far the most difficult part of the operation is to give the lenses a fine polish.

The best way of polishing these glasses, although not the simplest way of doing it, is, supposing the lens to be polished is a convex lens, to cover the concave tool with a layer of pitch, hardened by being melted with a little rosin. This covering of pitch should be laid on to about the thickness of one-fifteenth part of an inch. Then a piece of thin writing-paper is to be taken, and pressed upon the surface of the pitch by means of the convex tool; but the paper is to be pulled quickly from the pitch before it has begun to adhere to it, whose surface is then to be examined. If the surface of the pitch is every where marked with the lines of the paper, by this having coincided exactly with the surface of the convex tool, then it will be truly spherical; but if the marks of the paper do not appear on every part of the pitch, the operation must be repeated until the bed of the pitch is accurately spherical. If any paper sticks and remains on the surface of the pitch, it must be removed by soap and water.

The bed of pitch, or polisher, being thus prepared, the glass is to be wrought upon it by circular and cross strokes, alternately taken, either along with putty powder, or colcothar of vitriol and water, until it has received a good polish on both sides.

The polishing proceeds very slowly at first, but when the bed of pitch becomes warm by friction, it proceeds rapidly. When the polishing is nearly finished, no more powder or water should be put upon the pitch, which should be kept warm by breathing on it; and if at any time the glass moves difficultly, in consequence of its adherence to the tool, it should immediately be removed, lest it should spoil the regular sphericity of the pitch. Sometimes particles of dust, or fragments of pitch, get in between the glass and the bed of pitch, which is immediately shown by the very unpleasant manner in which the glass works; in this case, the polisher must be instantly stopped, and the foulness removed with great care, by washing both the glass and the bed of pitch, as otherwise the glass will be scratched, and the bed of pitch itself materially injured.

There is, as has been already suggested, a more simple way of polishing, by covering the layer of pitch with a piece of cloth, and giving it a spherical form by pressing it with the convex tool when the pitch is warm. The glass is then polished, upon the surface of the cloth, with putty or colcothar of vitriol, until its surface is sufficiently smooth. The operation of polishing by this method is slower than with pitch alone, but still it is the best for those who have had little or no experience in polishing, and who, in consequence of this want of practice, would be apt to injure the sphericity of the glass, by attempting to polish it on a bed of pitch.

Although colcothar of vitriol is mostly used for polishing glass, there is one inconvenience which attends its use; that often, from not being sufficiently washed, it contains a portion of undecomposed sulphate of iron. Now, when this portion of copperas is dissolved by the water, it leaves a yellow ochre, which readily penetrates the glass, and forms an incrustation upon its surface, and gives it a dull and yellow tinge, which is communicated to the optical images seen through it.

DOMESTIC GREENHOUSES AND FERNERIES.

(Resumed from page 34, and concluded.)

The ferns constitute an order of plants different from all others. Not bearing flowers, they are removed from the usual characters of those plants with which we are best acquainted, and yet their fine and delicate foliage, vivid green color, and elegant habit, exempt them from that neglect which flowerless plants usually meet with.

One species, "The Brake," as it is called, which spreads itself in much profusion over all our sandy commons, will give us a good idea of the general structure of the whole. The root is black, creeping, and shows out at intervals rather stout fibres. The frond, by which term is meant the whole of the plant which is above the ground, except the fruit, is at first carefully and beautifully rolled up, in a manner similar to a watch-spring. When beginning to grow it gradually uncoils itself upwards, and the side branches in like manner are afterwards unfolded, until the plant has attained its usual size. In a very short time after the expansion of the frond, various spots, mostly of a white color, are apparent in the under surface of different parts; these gradually increase, and soon show themselves to be a collection of thecæ—or rather seed-vessels—sometimes covered with a membrane, at other times without this membrane or *indusium*, and according to this circumstance, and according to the position of the sori or branches of the seed-vessels, so the ferns are divided into genera or families.

The thecæ, or seed-vessels, are of the most admirable formation, and under the microscope are seen to have a curious and wonderful appendage to scatter the seeds with which they are stored. In an early state the thecæ is round, thin, and furnished with a finely-knotted or jointed ring, which extends from one end to the other. When ripe, the ring becomes elastic, the thecæ tender, until at length it bursts asunder and continues to jerk backwards and forwards, until every seed has been thrown out.

The following cut shows the manner of some species bearing their fruit, and also the manner of its being scattered.

A are two species of foreign ferns, one with round sori, Polypodium aureum; the other with long sori, Asplenium. B is a thecæ, or seed-vessel. C is the seed from it. D is a species of fern in which the fructified portion is distinct from the barren frond. This is the adder's tongue, a plant not uncommon in some parts of England, in wet pastures.

The soil which suits best this tribe of plants is a sandy bog earth; such as is found in the upper part of boggy commons, mixed with white sand, is that which is best adapted for the general soil of a fern house. The plants will bear removal with little

injury in the spring of the year; even in the summer they may be removed with safety, provided they are kept constantly moist for some days after their transplantation; and as this state of moisture is a necessary consequence of the particular mode of cultivation here recommended, little difficulty or danger is likely to accrue.

Most of the damper parts of Great Britain produce more or less species of ferns, and some of them of the greatest beauty and fully equal to most of foreign growth. Some species grow naturally upon walls, others in the ditches and bogs, others, again, among the rocks of mountainous countries. One elegant little species (Hymenophyllum tunbrigense,) covers the high rocks at Tunbridge. Three other kinds are extremely common on walls (Asplenium adiantum nigrum, asplenium trichomanes, and asplenium ruta muraria); one or other of them may be found on most of the old churches and walls in England—for example, at Twickenham, Ham, Richmond, Greenwich, Charlton, Cobham, &c. &c. Different larger kinds are no [illegible]abundant in the damper parts of woods and commons. Aspidium filix-mas is abundant almost every where in the hedge-row ditches, where the root may be dry in the winter, never, therefore, in the ditches which intersect marshy land. Scolopendrium vulgare, Blechnum boreale, Asplenium Filix-fœmina, or Lady-fern, and Polypodium vulgare, are no less abundant in many places. The latter grows, mostly, either in old trees or on the summit of high hedge-banks. The former kinds in wet places, as Walter Scott remarks truly:—

> "Where the hedge-row is the greenest,
> Where the fountain glistens sheenest,
> Where the morning dew lies longest,
> There the Lady Fern grows strongest."

About London, the principal stations of these ferns, are the valleys of Wimbledon Common, and also around the well or spring near Cæsar's Camp. Another station is around Twickenham, as on the Countess Paulet's wall, and the ditches about Chasebridge, and onwards through Witton, many of the lanes near Brentford, Caenwood, near Highgate, and particularly Hampstead Heath, around the little pools of water in the marshy ground at the back of Jack Straw's Castle. In the country, we may mention the following situations where many kinds are to be found:—Rocks and swampy ground around Tunbridge, ditto around Dorking and Ryegate, ditto around Bristol; Belle Hag Rocks, near Sheffield; generally in similar situations, throughout Derbyshire, Lancashire, [illegible]shire; mountainous parts of the lake counties. I[illegible]ugh and Cumberland are particularly rich in ferns, so is Berwickshire. The Welsh and Scottish mountains and woods yield their own peculiar kinds—some of them found nowhere else in Britain; while Ireland is equally productive of numerous species, particularly in the Morne and Cunnamara mountains, Power's-court waterfall, and the district around Killarney.

This list might be extended to an almost unlimited degree, there being scarcely a fertile valley, or a rocky mountain, a shaded hedge-row, or a dilapidated building, throughout the whole kingdom, where some species or other does not flourish—of course, different kinds in different places. Thus, although some may be generally distributed from north to south, yet the ferns which abound in one county may be, and usually are, comparatively rare in other and distant places.

From the above it may be supposed that ferneries or domestic greenhouses are adapted for the growth of only the particular tribe of plants here described; such a supposition is extremely erroneous; the hot and damp atmosphere within them is particularly conducive to the rapid growth of foliage in general; thus, most plants will grow more luxuriantly than in ordinary situations, even the succulent vegetables, the genera Cactus, Stapelia, Crassula, Aloe and others, may be thus cultivated with complete success. Heaths, Ehacris, and different plants of a similar rigid character, seem to flourish well; indeed, it may be said, that the common and greenhouse plants in general find this artificial climate adapted to their habits. The Calla Æthiopica thus treated becomes a splendid plant; and that remarkable and curious family the Orchideous plants, which in the woods of Brazil, Sumatra, and other tropical regions, form the most brilliant festoons from tree to tree, may, in houses of the character here alluded to, be attached to bits of bark, the fibrous parts of cocoanut husks, or planted in baskets filled with moss—when they will grow luxuriantly, sustained merely by the constant moisture of the air, throwing out at the proper season their branches of singular, beautiful, and often fragrant flowers.

SAFFLOWER.

PINK SAUCERS, ROUGE, CHINA ROUGE BOOKS, AND CHINA LAKE.

Safflower, bastard saffron, or dyers' saffron, is the flower of a species of *carthamus*, being the *carthamus tinctorius* of Linnæus, who places it in his order *syngenesia polygamia æqualis*, while Jussieu arranges it in his order of *compositæ*. It is an annual plant, growing naturally in Egypt, but which is also cultivated, for the use of dyers, in the East Indies, and several of the warmer countries of Europe. Its stem is upright, firm, smooth, whitish, two or three feet high, divided at top into several branches, garnished with simple, undivided leaves, of an oval form, pointed, and edged with small spines. Each of these branches has at the top a large flower, composed of several florets, slightly cut in five jags, all of which are furnished both with stamens and pistils. These flowers are of a fine red color.

Safflower is collected for use as soon as it has blown, and is dried in a shady, dry place. If left until fully blown, it loses much of its fine color, and this lowers the value very greatly. When the safflower is of a bad color, it shows that it was collected in bad weather, or was badly dried, and that the coloring matter has by these means been spoiled.

Safflower is much used in dying; it contains two kinds of coloring matter, one of a reddish yellow color, which is not used because it only dyes dull shades of color. The other coloring matter contained in safflower is of a beautiful rose red, and is capable of dying every shade, from the palest rose even to a cherry red.

The first coloring matter is very easily dissolved in cold water; but the second, being of a resinous nature, is not soluble in that liquid. In consequence of this difference, they may be separated from one another by washing the safflower tied in a sack, laid in a trough, and trod by a man, while a slender stream of water passes through the trough, in order to wash away the yellow coloring matter. When the water with which it is washed no longer

becomes colored, the washing is discontinued, and the safflower, if not wanted for use, is made into cakes, under the name of stripped safflower. These cakes, or the loose stripped safflower, are then soaked in a weak solution of barilla in water (generally 6 lb of barilla to the cwt. of safflower); the bath, as the dyers term the infusion, speedily becomes colored of a deep reddish yellow.

As soon as the soaking of the stripped safflower in this bath is supposed to have been continued a sufficient time, it is strained, and carded cotton is dipped in it, and a sufficient quantity of acid is added, to completely saturate the alkali that was employed. Citron juice is usually employed for an acid, because it renders the colors more lively than other acids. The carbonic acid gas, or fixed air, which is disengaged during this saturation of the barilla, produces an effervescence, and care must therefore be taken that the liquor does not run over the edge of the vessel; and it is proper to add the citron juice, or citric acid, either in its brown or pure white state, in small portions.

The coloring matter extracted from the safflower being only kept dissolved by the help of the alkali, is of consequence separated in proportion as the alkali becomes saturated with the acid; but instead of settling on the sides or bottom of the vessel, it fixes in preference upon the cotton, with which it has what is commonly called an affinity.

It is not possible to separate in the first washing the whole of the yellow coloring matter; the part that remains is taken up by the barilla, and renders the shade of color given to the cotton rather dull; but this is easily got rid of by repeated washings. When it is well washed it is soaked again in a solution of barilla, and thus a bath of the perfectly pure resinous red coloring matter is obtained. In order to dye with this pure bath, the stuff to be dyed is soaked in the bath, and, as in the preparation, a sufficient quantity of citron juice, citric acid, or tartaric acid, is to be added.

If it be wished to obtain the coloring matter separate, as in the pink saucers, as they are called, the same operations are performed, with only this difference, that nothing upon which the coloring matter may fix should be put into the bath. By degrees there settles a very fine powder, the liquor is then decanted off, the settling washed, and distributed upon saucers, where, as it dries, it acquires a coppery tinge, which exhibits a reflection similar to that of Spanish flies. The rose-red color is produced as soon as this is wetted.

This coloring matter, mixed with French chalk, reduced to a very fine powder by means of scraping the chalk with Dutch rushes, is the cosmetic called vegetable rouge, used by the higher classes of females, especially in foreign countries, to paint their cheeks.

The Chinese, instead of saucers, use a folded piece of card, covered with Indian paper, to spread the red coloring matter upon; a finger being wetted, rubs off the color, which is a much neater method for the ladies than the saucers of the European perfumers.

The resinous matter may also be preserved in a mass, by merely drying the precipitate; it is then called Indian or China lake. It does not communicate any color to water, but produces a beautiful red tincture when spirits of wine are poured upon it.

When safflower is used to dye silk of a poppy or flame color, the silk must not be alumed, and a slight annatto ground is first given to it. For a pale carnation, a little soap is added to the bath. All safflower baths are made with cold water, and used cold, as heat spoils them.

METHOD OF PERMANENTLY FIXING, ENGRAVING, AND PRINTING FROM DAGUERREOTYPE PICTURES.

BY DR. BERRES.

Read before the Imperial Society of Vienna.

It was announced in the Vienna Gazette of the 18th of April last that I had succeeded in discovering a method by which I was enabled both permanently to fix the pictures produced by the method of Daguerre, and to render them available to all the purposes of etching upon copper, steel, &c., from which copies might be struck off to any extent, as in the case of ordinary engraved productions, and it was stated in the same newspaper, that I proposed bringing my discovery immediately before the public.

As a member of this distinguished Society I consider it my duty, first to make known to this learned body a discovery which creates so much hope, and which promises so great a benefit to the arts and sciences. The well known expenses and difficulties attendant on the publication of an extensive work, requiring engravings or illustrations, led me in the first instance to hope that I might be enabled to render the discovery of Daguerre available, by improvements, to represent and fix the objects necessary to my work; and the first view of an heliographed picture aroused in me the desire also to represent in the same manner microscopic objects, although attempts with the strongest lamp-light to produce engravings or etchings had been unsuccessful, and the idea abandoned as hopeless, until revived by a sight of the hydro-ogygen gas microscope of Mr. Schuh of Berlin, an instrument which in its power and clearness has never before been equalled or even approached. On the 27th of February last, I had the honor of laying before this learned body the results of the united investigations of my distinguished colleague, Professor de Ettingshausen, and myself, upon this subject, and the perfectly successful experiments of pictures prepared through the process of photography upon microscopic objects. Many [illegible] of the results of our researches and successful attempts to employ photography for scientific and useful purposes are now placed before you for examination. Through this new method the Daguerreotype is rendered more extensively available for scientific uses. Every object which is discernible to the eye with clearness can, for the future, through the means of the iodined silver plates, be minutely etched, and true to Nature, (for she is herself the artist!) be copied with the minutest exactness.

In a Petersburgh newspaper of March last, I first saw an account of some attempts to bring the Daguerreotype process into general use. In the meantime, M. Daguerre had declared, before the Institute of Paris, the complete failure of all his attempts, by means of etching, to obtain the impression of even a single copy.

The experiments at St. Petersburgh, and the hope of eventual success, urged me to attempt to make some use of the Daguerreotype pictures, and I began, at the commencement of this month, my

series of experiments. Without recapitulating all these, in which I was assisted with cordial zeal by M. Francis Kratochwila, (a gentleman in the employ of Government,) and by M. Schuh, who placed at my disposal an immense number of Daguerreotype plates—and, before I come to an explanation of the process by which I render these Daguerreotype pictures permanent and capable of further use—I consider it necessary to lay before this learned body the following observations :—

1st. With the copper plates, as used at present in the Daguereeotype process, we can effect only the permanently fixing, never the etching and printing of copies therefrom.

2d. For the heliographic etching it is necessary that the picture be produced with the required intensity, upon pure chemical silver plates.

3d. The etching of the Daguerreotype picture is produced through the influence of nitric acid, to be explained hereafter.

4th. For the permanently fixing of the Daguerreotype impression, a galvanic power is necessary.

5th. For the changing of the Daguerreotype picture into a deep metal etching, so as to be used as a means of printing, the chemical process of etching is of itself sufficient.

My newly discovered method of managing the Daguerreotype pictures may be divided into two processes :—

1st. That of permanently fixing the design.

2d. The changing of the design, when once permanently fixed, into an etching upon the plate.

The method of permanently fixing the Daguerreotype picture with a transparent metal coating, consists in the following process :—

I take the pictures produced in the usual manner, by the Daguerreotype process, hold them for some minutes over a moderately warmed nitric acid vapor, or steam, and then lay them in nitric acid of 60 to 63°, (Fah.) in which a considerable quantity of copper or silver, or both together, has been previously dissolved. Shortly after being placed therein, a precipitate of metal is formed, and can now be changed to what degree of intensity I desire. I then take the heliographic picture coated with metal, place it in water, clean it, dry it, polish it with chalk, or magnesia, and a dry cloth, or soft leather. After this process the coating will become clean, clear, and transparent, so that the picture can again be easily seen. The greatest care and attention are required in preparing the Daguerreotype impressions intended to be printed from. The picture must be carefully freed from iodine, and prepared upon a plate of the most chemically pure silver.

That the production of the picture should be certain of succeeding, according to the experiments of M. Kratochwila, it is necessary to unite a silver with a copper plate; while upon other occasions, without being able to explain the reason, deep etchings or impressions are produced without the assistance of the copper plate, upon pure silver plates.

The plate should now, upon the spot where the acid ought not to have dropped, be varnished; then held for one or two minutes over a weak warm vapor or steam, from 88° to 100° (Fah.) of nitric acid, and then a solution of gum arabic, of the consistence of honey, must be poured over it, and it must be placed in a horizontal position, with the impression uppermost, for some minutes. Then place the plate, by means of a kind of double pincers (whose ends are protected by a coating of asphalt or hard wood), in nitric acid at 60° (Fah.) Let the coating of gum slowly melt off or disappear, and commence now to add, though carefully and gradually, and at a distance from the picture, a solution of nitric acid, of from 80° to 100° (Fah.) for the purpose of deepening or increasing the etching power of the solution. After the acid has arrived at 68° to 70° (Fah.), and gives off a peculiarly biting vapor, which powerfully affects the sense of smelling, the metal becomes softened, and then generally the process commences of changing the shadow upon the plate into a deep engraving or etching. This is the decisive moment, and upon it must be bestowed the greatest attention. The best method of proving if the acid be strong enough is to apply a drop of the acid in which the plate now lies to another plate; if the acid make no impression, it is of course necessary to continue adding nitric acid; if, however, it corrode too deeply, then it is necessary to add water, the acid being too strong. The greatest attention must be bestowed upon this process. If the acid has been too potent, a fermentation of white froth will cover the whole picture, and thus not alone the service of the picture, but also the whole surface of the plate, will quickly be corroded. When, by a proper strength of the etching powers of the acid, a soft and expressive outline of the picture shall be produced, then may we hope to finish the undertaking favorably. We have now only to guard against an ill-measured division of the acid, and the avoidance of a precipitate. To attain this end, I frequently lift the plate out of the fluid, taking care that the etching power shall be directed to whatever part of the plate it may have worked the least, and seek to avoid the bubbles and precipitate by a gentle movement of the acid

In this manner, the process can be continued to the proper points of strength and clearness of etching required upon the plates from which it is proposed to print. I believe that a man of talent, who might be interested with this art of etching, and who had acquired a certain degree of dexterity in preparing for it, would very soon arrive at the greatest clearness and perfection; and, from my experience, I consider that he would soon be able to simplify the whole process. I have tried very often to omit the steaming and the gum arabic, but the result was not satisfactory, or the picture very soon after was entirely destroyed, so that I was compelled again to have recourse to them.

The task which I have undertaken is now fully performed, by placing in the hands of this learned body my method of etching and printing from the Daguerreotype plates, which information, being united to the knowledge and mechanical experience we already possess, and published to the world, may open a road to extensive improvement in the arts and sciences. By thus laying open my statement to the scientific world, I hope to prove my devotion to the arts and sciences, which can end only with my life.—*Athenæum.*

MANUFACTURE OF STARCH.

Potato Starch, or English Arrow-root.—It presents very varied forms, and no other known kind acquires so large a size. When first obtained from the organs of the plant, it exhibits concentric wrinkles on its surface which disappear as it dries. The largest grains are about .0049 of an inch in size. The most common size is from .004 to .0015.

They are oval, contracted in the middle like the cocoon of the silk-worm, gibbous, obscurely triangular, or rounded; and the smallest are spherical. The potato is the only plant whose fecula is used for culinary purposes, as it can be obtained at a cheaper rate than any other. To extract it, the tubercles are washed and scrubbed, after which they are rasped under a stream of water, which carries the raspings to a sieve, through whose meshes the fecula alone passes into a vessel placed below. When the operation is finished the water is poured off, and the fecula is repeatedly washed until the water carries off no soluble matter; after which it is dried in the sun or in a stove. This fecula then has the appearance of an impalpable crystalline powder, having a white color with a slight blueish tinge. The grains are less altered in this than in any other variety of fecula.

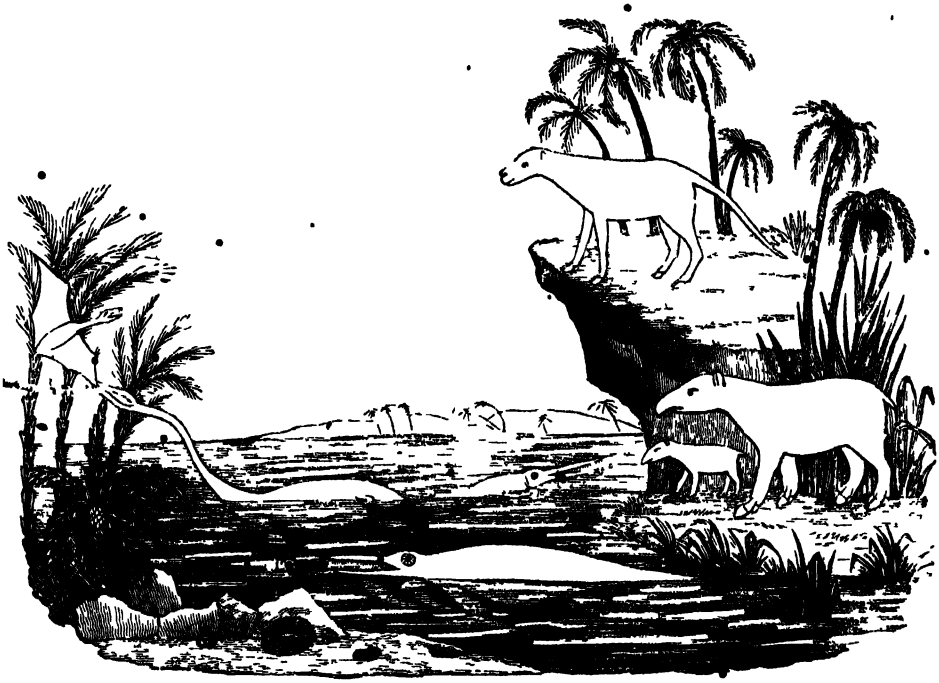
Wheat Starch, or Hair Powder.—The largest grains of this do not generally exceed .002 of an inch in size; they are spherical, and along with them we see empty and torn membranes resulting from the bruising of the grains by the mill. They are much smaller, rounder, and better preserved, when they are extracted from the grain while it is greenish and not ripened on the stalk. It is extracted in the following manner for the use of laundresses, who prefer the starch of it to any other for dressing fine linen:—The starch-makers place in large vats the wheat roughly ground, and without separating the bran, and employing even the refuse of flour and damaged wheat. They diffuse the farina in a certain quantity of water, adding a little "sour," which is the product of a preceding operation. The sugar and the gluten which the farina contains speedily act on each other, and produce, at first, carbonic acid and alcohol, and afterwards acetic acid, which completes the solution of the gluten. It is this solution which is called the "sour," or "fat water." It is muddy and viscid. According to Vauquelin, it contains acetic acid, alcohol, acetate of ammonia, phosphate of lime, and gluten. After having washed the deposit by decantation, it is diffused in water, and thrown on a hair sieve placed over a tun. The coarsest of the bran remains on the sieve. The fecula and the finer part of the bran pass through and subside together. This deposit is again mixed with water; and, on allowing it to rest, the fecula, being the heavier, is first deposited, and the bran forms the upper layer of the precipitate. A portion of this is taken off with a shovel, and by repeatedly washing the upper part of the remaining mass additional portions are removed. The residue is mixed with water, and passed through a sieve made of silk. Thus a fresh portion of the bran is got rid of, and nothing more is required but to let the fecula subside, and wash it, in order to obtain it pure. Lastly, it is dried by taking it up in wicker baskets having a loose linen lining, and turning it out of these moulds on an area coated with plaster. The blocks of starch thus formed are broken down by the hand, their fragments are exposed for some days to the air, their surface is smoothed, and they are carried to the stove to be perfectly dried. The lumps of starch thus obtained have a certain regularity of shape, which seems to indicate a rude crystallization; but it proceeds only from the action of the water, which cracks the mass in draining out of it. This starch is always less friable than that of the potato, in consequence of a certain portion of gum and sugar which its particles, as they subside, envelope among them. It is suitable enough for the extraction of fecula from all the vegetable organs which contain gluten—from barley, for example, which the starch-makers use as well as wheat.

MISCELLANIES.

Lapidaries' Work.—The wheel made use of by the Hindoos for the cutting and polishing of precious stones is composed of one part of gum lac, and two parts of powdered emery (or conundrum.) The emery powder is first heated in an earthen vessel, and when the heat is sufficient to melt the gum, it is added in small portions, stirring the whole about to promote the union. The paste thus made is beaten with a pestle on a smooth slab of stone; afterwards it is rolled on a stick, and reheated several times. The mixture being uniform, it is taken from the stick and laid on a stone table previously covered with the fine emery powder, where it is flattened into the shape of a wheel by an iron rolling pin. The wheel is then polished by an iron plate and emery powder, and a hole made through the middle for an axis by a hot rod of iron. When mounted, it is fixed with its axis in a horizontal direction, and the workman causes it to revolve by means of a spring bow held in his right hand, while he holds the stone to be cut in his left, occasionally applying emery and water. The polishing he effects by leaden wheels and a fine powder.

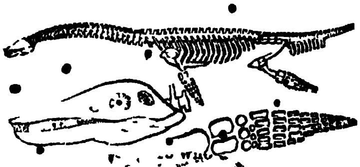
Grafting.—D. Powel, Esq., of Loughton, Essex, recommends the following method of securing the scion when fitted to the stock in grafting:—Spread the wax in a melted state *evenly* on sheets of moderately thin brown paper, and when cold cut it into slips about three-quarters of an inch wide; warm one of these slips with the breath, and bind it round the stock and scion, pressing it gently with the hand, when it will be found to adhere so closely as totally to exclude both air and moisture. The wax may be prepared by melting together 1 lb. of pitch, 1 lb. of resin, ¼ lb. of bees' wax, ¼ lb. of hogs' lard, and ¼ lb. of turpentine. By placing the composition in an earthen pan over boiling water, it may be kept in such a state of fluidity as to be easily spread on the paper with a brush.

Flexible Marble of Berkshire, United States.—Dr. Davey states that [illegible] marble, which has been known for [illegible] years, [illegible] until lately was found chiefly at Stockbridge and Lanesburgh, is now obtained at New Ashford, from an extensively wrought [illegible]. He had three fine specimens of it in slabs, from five to six feet in length, and seven inches in width. Its flexibility and elasticity may be shown as it stands upon one end, by applying a moderate force to the middle or the other end. Its flexibility is seen, too, by supporting the ends of it in a horizontal position upon blocks. The marble has various colors nearly white, with a reddish tinge, grey, and dove-colored. Some of it has a fine grain, other specimens are coarsely granular, and have a loose texture. It is not uncommon for one side of a large block to be flexible, while the other part is destitute of this property. It takes a good polish, and appears to be carbonate of lime, and not a magnesian carbonate.

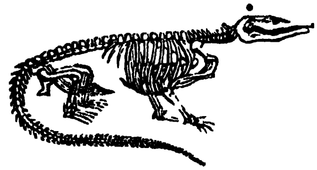


6. 5. 4. 3. 2. 1.

No. 1, *Palæotherium magnum.*—2, *Palæotherium minus.*—3, *Anoplatherium commune.*—4, *Ichthyosaurus platyodon.*—5, *Plesiosaurus dolichodeirus.*—6, *Pterodactylus.*



Skeleton of Plesiosaurus dolichodeirus.



Skeleton of a Crocodile.

ORGANIC REMAINS.

Mr. Lyell remarks in his "Geology," that a close comparison of recent and fossil species of animals, and the inferences drawn in regard to their habits, accustoms the geologist to contemplate the earth as having been at successive periods the dwelling place of animals and plants of different races; some terrestrial and others aquatic; some fitted to live in seas, others in the waters of lakes and rivers. By the consideration of these topics, the mind is slowly and insensibly withdrawn from imaginary pictures of catastrophes and chaotic confusion, such as haunted the imagination of the early cosmogonists. Numerous proofs are discovered of the tranquil deposition of sedimentary matter, and the slow development of organic life. The growing importance then of the natural history of organic remains may be pointed out as the characteristic feature of the progress of the science during the present century. This branch of knowledge has already become an instrument of great utility in geological classification, and is continuing daily to unfold new data for grand and enlarged views respecting the former changes of the earth.

In taking a brief review of the progress of vital existence, from the earliest period of the earth's history to the last great changes, it is requisite to refer to the position of the various rocks and deposits upon each other, as explained in page 18. The primary or unstratified rocks, as there explained,

consist of such as formed the first crust and which constitutes the lowest bed upon which all the rest are placed. These primary rocks contain no remains of organic matter which ever had life, or it should rather be said that we have yet discovered none, either animal nor plant.

The range of rocks which come immediately over these is called the Grauwacke group, and consists of slates, transition limestones, &c., and abound with fossil remains, of such a nature as to show a very great variety of structure, habit, appearance, and locality. No mammalia nor reptiles are yet discoverable, but the various slate and limestone beds contain many species, which, although bearing but an extremely minute proportion to the vast mass of the earth, are yet the nucleus from which to date our researches. The plants of this group are about twelve in number, and consist of gigantic Ferns and Equisetums, nor it is supposed capable of sustaining animal life, though what other more fragile plants might have existed we have no records remaining of. Of Zoophites or Corals there have been discovered about 100 species; of Mollusca, Radiata, and Crustacea 460 species; of Fish 2 species.

The Carboniferous group, or Coalmeasures, yield animals of similar organization, and in greater abundance; this period also produces various coniferous trees, which did not before exist. The whole number of genera and species varies but little with those discoverable in the former group, and very numerous genera run through both.

The red sandstone group valuable as it is to the builder and the miner, is yet not more prolific in fossil remains than the former deposits, yet here we first find reptiles, showing another approach towards the present races of animals. In the variegated marls, no less than four gigantic reptiles have been discovered, the Phytosaurus, Mastodonsaurus, Ichthyosaurus, and Plesiosaurus. In other of the sandstone group, the same or similar *Saurians*, or reptiles, are found.

The Oolitic group which contains among other rocks the lias, yields very numerous species. The remains of plants are, however, so little varied that we are not enabled to form a judgement of the general vegetation of this period of creation, but animal existence offers itself to our notice with continued progress of development. Shells are common both univalve and bivalve, so are also the zoophytes and other animals of simple organization. Reptiles too are by no means rare, either in this country or on the continent. Insects here first make their appearance. Fish are of very frequent recurrence, a bird and two species of mammalia (the Didelphis) have been found. Of the various reptiles of this period, the Ichthyosaurus, particularly the I. platyodon, seems to have been best adapted to rule in the waters; its powerful and capacious jaws, sometimes eight feet in length, being an overmatch for the crocodiles and plesiosauri of this period. Strange inhabitants these, for as Cuvier says, "the Ichthyosaurus has the snout of the dolphin, the teeth of a crocodile, the head and sternum of a lizard, the extremities of cetacea, and the vertebræ of fish; while the Plesiosaurus has, with the same cetaceous extremities, the head of a lizard, and a neck resembling the body of a serpent." We have given in the former page two small cuts illustrative of the skeleton of the ancient Plesiosaurus and the modern crocodile, that their general similarity may be compared. It is almost unnecessary to say that these two genera have disappeared from the surface of our planet. We must not forget more particularly to allude to the first bird. The Pterodactyles—one of which is represented in the cut being caught by the Plesiosaurus. Upon the Oolite reposes the Wealden rocks, in the bed of which has been discovered that enormous serpent the Iguanodon, together with Crocodiles, Tortoises, and other reptiles. While upon this is seated the chalk, in which deposit the larger reptiles which were so frequent at a former period, are no longer discoverable. The remains of the crocodile, and one or two other reptiles, are all that have yet been dug up.

Above the chalk we first discover frequent traces of mammiferous animals. In the Gypsum is Paleætherium magnum, minus, and many other species. Anoplotherium commune and others, the remains of some canine animal, one which must have resembled a squirrel, and many hundreds of species of shells.

The marle, clays, and gravel above the chalk yield a still greater number of fully organized creatures and vegetables. The fossil fruits show a higher order of vegetation, and the frequent discovery of the fossil remains, and even unchanged bones of the Mastodon, Hippopotamus, Tapir, Deer, Horse, Ox, Hyæna, Bear, Fox and Porcupine show not only the recent formation of this description of rocks, if such they can be called, but bring us down to a period but little antecedent to that of the present creation—when the world was filled with creatures similar, or nearly similar to those which now roam over its surface.

PAINTING IN CRAYONS.

By crayons we understand in general all colored stones, earths, or minerals, and substances used in drawing and painting in *pastil*, whether these substances are used in their original consistence and only cut into long narrow slips for use, or reduced to a paste with gum water, &c.

Of the Materials used in Crayon Painting.—The perfection of the crayons consists in a great measure in their perfect softness, for it is impossible to execute a brilliant picture with them if they are otherwise. The best pastils or crayons are those imported from Switzerland, but being more expensive than those made here, they are now manufactured nearly as fine in London; the principal, with their different shades, are as follows:—white, black, yellow, orange, purple, red, blue, green and brown. Rough Venice paper, which is of a [illegible] brown color, the stiffer the better,—strong blue paper, which it is almost impossible to get entirely free from knots; such knots must be levelled with a pen-knife, or razor, otherwise they will prove troublesome. Cap paper is a very good sort, as it distributes the colors to the best advantage. The paper must be pasted very smooth on a linen cloth, previously strained on a frame, which may be done by drawing and fastening a piece of linen with small tacks round the edges till quite smooth; damp your paper with a sponge dipped in water. Paste it, laying it on the cloth, being particular that it is even with the straining frame; placing a piece of white paper upon the table, put the straining frame with the paper downwards upon it, keeping it steady with one hand, rub the cloth gently to the paper with the other, then turning the frame with a piece of

white paper in your hand, rub close the edges; when the paste is perfectly dry you may proceed with the painting. The artist in order to keep his colors separate should be prepared with a box, divided into a number of partitions. The crayons should be deposited according to the several gradations of lights. The box made use of should be about a foot square with nine partitions. In the upper corner on the left hand, (supposing the box to be in the lap when he paints, which is the best position,) let him place the black and grey crayons; in the second partition, the blues; in the third the greens and browns; in the first partition on the left hand of the second row, the carmines, lakes, vermillions, and all deep reds; the yellows and orange in the middle, and the pearly tints next in the lowest row; let the first partition contain a piece of fine linen rag, to wipe the crayons with while using them; the second, all the pure lake and vermillion tints; and the other partitions may contain those tints which from their complex nature cannot be classed with any of the former.

Directions for using the Crayons.—When the student paints immediately from the life, it will be most prudent to make a correct drawing of the outline on another paper the size of the picture he is going to paint, which he may trace by piercing the drawing with pin holes pretty close together. The paper intended to be used for the painting must be laid upon a table, and some fine pounded charcoal tied up in a piece of lawn; rub over the perforated strokes which will give an exact outline.

The student will find that the sitting posture, with the box of crayons on his lap, the most convenient method for him to paint; that part of the picture on which he is at work should be somewhat lower than his face, otherwise the arm will be fatigued. The windows ought to be darkened at least six feet from the ground, and the subject to be painted should be situated in such a manner that the light should fall with every advantage on the face, avoiding too much shadow, which seldom has a good effect in portrait painting, especially if the face he paints has any degree of delicacy. The features of the face being carefully drawn with chalk, take a crayon of pure carmine, and carefully draw the nostril and edge of the nose; next the shadow; then with the faintest carmine tint, lay in the strongest light upon the nose and forehead, which must be executed broad; then proceed gradually with [illegible] and the succeeding ones, till he arrives at the [illegible]ows, which must be covered, brilliantly enriched w[illegible] lake carmine, a little broken with brilliant green.

This method will at first offensively strike the eye, from its crude appearance, but in finishing it will be a good foundation to produce a pleasing effect, colors being much more easily sullied when too bright than when the first coloring is dull; the several pearly tints discernable in fine complexions must be made with blue verditer and white. When you begin the eyes, draw them with a crayon inclined to the carmine tint. Whatever color the irises are of, lay them in brilliant, and at first not loaded with color, but executed lightly; no notice is to be taken of the pupil yet; let the light of the eye incline very much to a blue cast, cautiously avoiding a white staring appearance, (which when once introduced is seldom overcome,) preserving a broad shadow thrown on its upper part by the eye-lash.

A black and heavy tint is also to be avoided in the eye-brows, it is therefore best to execute them like a broad glowing shadow at first; on which in the finishing, the hairs of the brow are to be painted, by which method the former tints will show themselves through, and produce a pleasing effect. Begin the lips with pure carmine and lake, and in the shadow use some carmine and black; the strong vermillion tints should be laid on afterwards, from the corner of the mouth with carmine, brown and greens variously intermixed. If the hair is dark you should preserve much of the lake and deep carmine tints thereon; after you have covered over, or dead colored the head, you must sweeten the whole together with the finger, or a *stump*. Beginning at the strongest light upon the forehead, be cautious not to smooth or sweeten it too often, as it will give it a thin and scanty effect; if you find it necessary you must replenish the picture with more color. When the head is tolerably adorned, the back ground is to be begun, but in a different way; it is laid in very thin and rubbed into the paper with a stump. Near the face the paper should be almost free from color, as by its thinness it will give both a soft and solid appearance; the above method being properly executed will give the appearance of a painting principally composed of three colors, viz., carmine, black and white, which is the best preparation for producing a fine crayon picture.

The next step is to complete the back ground and the hair, as the dust in painting these will fall on the face and injure it; from thence proceed to the forehead finishing downwards. In painting over the forehead the last time, begin the highest light with the most faint vermillion tint. In the next shade succeeding the lightest, you must work some light blue tints, composed of verditer and white, and sweetening them together with great caution; some brilliant yellows may also be used, but sparingly, and towards the roots of the hair strong verditer tints mixed with greens will be of service. Cooling crayons composed of black and white should succeed these, and melt into the hair beneath the eyes, the pleasing pearly tints are to be preserved. In finishing the cheeks let the pure lake clear them from any dust; then with the lake may be intermixed the bright vermillion. The eye is the most difficult feature to execute in crayons. When you want a point to touch a small part with, break off a little of your crayon against the box which will produce a corner fit to work with in the minutest parts.

The difficulty with respect to the nose is to preserve the lines distinct, and at the same time so artfully blended into the cheek as to express its projection, and yet no real line be perceptible. The shadow of the nose is generally the darkest in the face, carmine and brown ochre, carmine and black will compose it best. In finishing the lips, use strong vermillions, but with great caution. In coloring the neck, preserve the stem of a pearly hue, and the light not so strong as on the chest: if any part of the breast appears, its transparency must also be expressed by pearly tints, but the upper part of the chest should be colored with beautiful vermillions delicately blended with the other.

CHALK DRAWING.

Charcoal is used for slightly sketching in the outlines of figures in order to get the proportions

previous to making a drawing in chalk. The best charcoal for this purpose is that of the willow; it is cut into slips, and the strokes made with it may be easily rubbed out.

Black chalk is a fossil substance resembling slaty coal, which is cut into slips for drawing. It is generally used in a port crayon; it is much employed for drawing figures, and is the best substance for this purpose in making drawings from plaster figures, or from life. It is more gritty than black lead, but is of a deeper black, and has not the glossiness of the former; it may be procured hard or soft—the best is of two kinds, the French and Italian. White chalk is used together with black, for laying on the light for mellowing and softening the shadows into each other. *Stumps* are used—they are pieces of soft leather or blue paper, rolled up quite tight and cut to a point. *Middle tint paper* is of a brownish, or grey color, which is used for drawing upon with black and white chalk.

In drawing after a plaster figure the eye will easily discover the general light and shade; the mass of light should be kept broad and be well attended to before the smaller parts are divided. The outline should be exceedingly faint in such parts as receive the light. The shadows may be laid on by drawing parallel curved lines according to the situation of the part, crossing them occasionally, and softening them in with more delicate lines when necessary. All the parts of a human figure are composed of curved surfaces, no straight lines are ever admissible; every line should have a graceful turn. Care should be taken that no lines ever cross each other at right angles, neither should the crossings be too oblique, as then they are confused; a proper medium will be acquired by the study of good drawings, or prints. Rubbing the shadows in with a stump is a very expeditious way, and produces a fine effect, but it should be used with discretion, as it is better to execute the shadows in a clear and regular manner by soft lines.

ON THE FLAME OF A CANDLE.

On examining the flame of a common candle, we find that it consists of three different portions; the lowest part which is blue, the dark centre, and the main body of the light which is the brightest. The cause of these differences we shall proceed to explain, premising, however, that the flame of the candle is caused by the ignition of the carbon into which the wax or tallow is converted by the red hot wick.

This carbon at the lowest part of the flame immediately meets with a current of fresh air, and is effectually burned, none escaping in an ignited state, which is the case higher up. That this is the true reason may be proved by supplying plenty of air to the upper part by means of a blowpipe, when that portion will become blue on account of the sudden and complete combustion of its carbon by the full supply of air.

Higher up, however, through the greater quantity of carbon evolved, and the rarefaction of the atmosphere in its immediate neighbourhood by the heat, the supply of air is less; and, consequently, the carbon is diffused and floats in an ignited state during combustion, and is not completely burned, for a portion remains unconsumed in the shape of smoke, or soot, as is seen by holding a piece of wire in the upper part of the flame when it will soon be covered with soot, which is not the case when it is held in the blue portion, where all the carbon is immediately and completely consumed; and as the air is most rarefied and heated at the top, (which is the cause of the pointed shape of the flame,) therefore at that part the carbon receives least air, and consequently most smoke is evolved.

But in the interior of the flame the carbon can receive no air, whence it is unconsumed while there and forms the dark central part. This unburnt vapour of carbon may be led away by means of a short tube, at the end of which it can be ignited, thus forming a second flame, which if large enough might be treated in the same way, thus producing a third; and satisfactorily demonstrating that the dark portion consists of the unburnt carbon.

These then are the reasons of the various colors in the flame; at the lowest part the carbon is completely and suddenly burned, producing the blue flame; in the interior it is unconsumed, forming a dark centre, and on the outside it floats in a state of ignition during combustion, the supply of air not being sufficient to produce complete combustion.

From our knowledge of the construction, if we may so term it, of the flame, we derive several practical advantages; for we see that by introducing a supply of air into the centre of the flame it would be consumed and the light increased. On this principle the Argand burner is formed, where the air rushes up the interior of the tubular wick; thus the carbon gets more air and the light is increased. Yet the carbon is now entirely consumed and soot is formed, so that if we could draw more air to its support by any means, the smoke would cease and the light would be brighter. This we effect by the lamp glass, which acts as a chimney, creating a swift ascent of fresh air, and yet by its transparency offering no impediment to the light.

But if the wick be turned up too high, more carbon is evolved than can be consumed, and it therefore smokes, which is also the case where the air holes are stopped by dirt, burnt wick, oil, &c.

And, in conclusion, by greatly augmenting the supply of air by the blow-pipe, the heat and intensity of the flame is so much increased that we are enabled to fuse glass, and even metals.

COFFEE.

The coffee shrub is a plant of the same family as madder, namely the rubiaceæ of Jussieu, and is arranged by Linné in his class Pentandria, and order Monogynia. There are several species of coffee; but the only one cultivated for use is the Coffea Arabica of modern botanists. It is a native of the Upper Ethiopia, and grows about 14 or 20 feet high: the branches come out in pairs, opposite each other, and crossing the pair of branches that come out below and above them; the leaves are somewhat like those of the bay, but less dry and thinner; the flowers are white, and succeeded by a berry like a cherry, filled with a yellowish pulp, and two small horn-like beans, flat and grooved on one side, and convex on the other.

It was a few years before 1500 that the infusion of these berries came into use as a drink, and it

has slowly extended itself through most parts of the civilized world, except China and Morocco, in which the use of tea is more common than that of coffee drink.

The Coffee Tree.—*Coffea Arabica.*

It was probably the elastic horny nature of these beans, which renders them very difficult either to powder or for the water to penetrate, that originally led the users of coffee drink to roast the beans to a brown color, in order that they might grind them more easily, and extract the virtues of it more speedily. The roasting not only perfectly answers these purposes, but also developes the aroma or odorous principle of the coffee bean.

In order to roast coffee properly, the uses of roasting must not be lost sight of, namely; to destroy the horn-like tenacity of the green bean, and to develop its fine scent. Too much heat would destroy the chemical elements which ought to be preserved, and would substitute in their place others which are entirely different in quality. That fine scent, which pleases so greatly the admirer of good coffee, is succeeded, when the coffee is over-roasted, by a bitter taste and burnt smell, which is far from pleasant, and even disagreeable. If, on the other hand, the roasting process is under-done, and the heat to which the beans have been exposed has not been sufficient, then the raw smell of the coffee remains, and of course diminishes the aroma, which requires a certain heat to develop it. There is of course a just medium to be observed. Well-roasted coffee ought to have a pale chocolate color equally spread over it, which is well known to those who are in the habit of performing this operation; but it is never necessary to look at the roasted beans, the scent is sufficient; for when the true aroma is developed, and fills the surrounding atmosphere with its delicious scent, then is the time to stop the roasting. After this period, the oil acquires a burnt flavor, a scent somewhat resembling that exhaled by smokers of tobacco is perceived, and instead of good roasted coffee, there is obtained a bad kind of charcoal.

Considering the importance of this operation, it is no wonder that some of those who are very fond of coffee drink, although they would feel ashamed in busying themselves in any other department of household economy, yet do not hesitate to roast their own coffee, not only at home, but even with their own hands. The fragrancy diffused by the roasting seems to delight them; and they appear to enjoy, by anticipation, the pleasure they shall feel in the drinking of the infusion.

Good raw coffee loses from 16 to 20 per cent. of its weight by roasting; if it loses more it is certainly over-roasted. Many different modes are used, and each has its admirers; but there is in fact only a single rule to be observed, namely, to use the proper degree of heat, and keep it up at the same point until the roasting is finished. Whether the roasting is performed in close or open vessels; whether the coffee is left to cool in the roaster, or is turned out, or even laid between cloths, appears indifferent. If, indeed, the roasting is carried by accident too far, the coffee should be immediately spread out thin on the floor, to cool it as soon as possible. In all cases, when cold, the roasted coffee should be put into tin-plate boxes, and kept from any moisture.

The chemists have made comparative analysis of raw and roasted coffee, of which some account may hereafter be given; but at present there is room only for detailing the best modes of making the coffee drink.

It being well known that the chemical action of solvents is hastened, in general, by reducing the solvent to powder, it is necessary to grind the roasted coffee more or less fine, as it is intended to use the water less or more heated. To reduce coffee to too fine a powder, although it would require only slightly warm water to extract its soluble parts, yet it would be inconvenient in other respects, for the powder would pass through the strainers of the coffee pot, and by also remaining suspended in the water would render the clearing of the drink difficult. At all events roasted coffee should never be ground but the moment before it is used, as otherwise it loses much of its fine scent.

It now remains only to say a few words respecting the making of the ground roasted coffee into drink,—and here the grand points are, not to lose the fine aroma, and not to extract the bitter, acrid, resinous element of the coffee. To avoid both these inconveniences, it is necessary that the coffee drink should not be made with too much heat as this would dissipate the aroma in vapours, and cause the water to dissolve the resin. The coffee, therefore, must not be boiled in the water, and still less is it proper to boil the grounds over again with fresh water, as is done by some persons. Coffee drink made from the grounds, when it is added to that made from fresh ground coffee, gives it indeed a fine deep color, but the taste of the drink is very bad.

It is not even necessary to pour boiling or even warm water upon the ground coffee: cold water, if sufficient time is allowed, makes equally good coffee drink, for the elements to be extracted from the roasted coffee are extremely soluble in water. But if the coffee is required to be prepared in haste, hot water must be used.

It is universally agreed on by the French amateurs of coffee, that coffee drink is never so good as when, after being made with cold water, or with hot water and cooled, it is heated over again, carefully avoiding a boiling heat. This heating over again is supposed to cause the various elements which produce the fine flavor of this drink, to unite more intimately; and this may be the real fact. The excellency of the coffee sold at Paris is well known; and this is always made one day and heated over again the next day, when wanted. A further advantage attends this knowledge, of consequence to single persons who, in summer time, do not keep a fire in their chambers, that by

merely pouring cold water on the ground coffee over night, and straining it in the morning, the strained liquor may, while they are dressing, be heated sufficiently for drinking over a lamp; and this gives coffee a superiority over tea for the breakfast of such persons; as tea requires the water to be boiling hot, in order to extract its virtues; and of course requires a fire to be lighted.

PREPARATION OF CATGUT.

Catgut for Clock-makers.—This kind must be very fine; and of course requires the smallest intestines, well prepared with potash. Sometimes they are made by cutting, with a particular kind of knife, the intestine into two strips. The knife, which is fixed on a table, has two edges, in opposite directions; and above them a ball of lead, which is introduced into one end of the intestine: and by drawing the latter continually over the ball, the projecting blades cut it into two strips, which the workman holds, one in each hand, drawing them regularly till it be cut quite through.

Watch and clock-makers also use catgut of various sizes, consisting of more than one intestine, and made like the musical instrument cords; which we shall next describe.

Catgut for Musical Instruments.—Of all the cords from intestines this kind is the most difficult to make, and requires the greatest care and ability of the workman. It is acknowledged that for many years they have been made in England as well as in Italy, with the exception of the treble-strings for violins, which our manufacturers have not been able to imitate, but on a very limited scale. This is either owing to the difference in quality of the intestines, or some other unknown cause. Whatever it be, we are still tributary to Naples for this article; and every exertion ought to be made to free us from this necessity. Experiments, made with skill, will no doubt succeed; and the Society for the Encouragement of Arts, by calling the attention of artists to this subject, will have the glory of contributing to the perfection of an art of which little is at present known.

The cleaning and scraping of the intestines for this purpose, to free them from the fat, must be done with much more care then is requisite for other cords; and when they have undergone that process, they must be steeped in an alkaline lye, prepared as follows:—

An earthen pan, holding six quarts, is filled with water, and three pounds of potash are added to it; which must be well stirred, and suffered to subside. In a similar vessel, full of water, placed by the side of it, are put five pounds of pearl-ash; leaving that also to settle. If it be wished to make use of this solution within a short time, it will be necessary to add to it a little alum-water, which will clarify it quickly.

The scraped intestines are now put into earthen pans, so as about to half-fill them. The pans are then filled up with the solution of potash, with as much water added as to double the quantity of fluid. This liquid is changed twice a day, increasing its strength each time, by adding more of the solution of pearl-ash, and diminishing progressively the quantity of water; so that the last solutions be the strongest. The intestines gradually become whiter, and begin to swell. After having suffered them to macerate from three to five days, or more according to the state of the atmosphere, the operation proceeds as follows:—

Every time that the alkaline solution is changed, the pans are placed upon the box called the *re-refreshers*, placed on a table, or on tressels, in a slanting direction, so as to facilitate the running off of the water. This box must be large enough to hold the frame on which the cords are to be stretched. The intestines are scraped with the edge of a copper cube held in the left hand. The forefinger of the left hand is placed near to the edge of the copper cube; whilst with the right hand each intestine is drawn over the edge of the disk or cube, and between the forefinger.

When they have all been treated in this manner, and placed in a fresh pan, a stronger alkaline solution is poured on to them than that from which they were last taken, as we have before mentioned. This operation is necessary for cleansing the intestine of its greasy quality, and bringing the cords to perfection.

As soon as it is perceived that the intestines begin to swell, and some little bubbles appear on their surface (for in this state they rise in the water,) it is necessary to twist them *immediately*, or they will begin to shrivel; which sometimes happens, particularly in summer, and occasions the loss of the intestines, and also the time spent over them. In hot weather, the intestines are, indeed, most easily cleaned from fat; but then the workman must be more than ordinarily attentive; and the different lyes for the washings must be made stronger with alkali, and applied more quickly. In winter, all goes on in better order, and the operation is more certain. The manufacturers of this article generally place their workshops in cool places, where there is a little dampness.

The intestines being now ready to be twisted, they are taken out of the akaline solution. Some manufacturers plunge them again into fresh water, and wash them well therein; but, although they become, by this method, of a better color, and take the sulphur better, they run the risk of being weakened.

To twist and finish the cords a machine is used—a kind of frame, two feet high, and five feet long; on one end of which are placed a number of pegs; and in the opposite end are bored, with a large auger, a number of holes, inclined in such a way, that when pegs are placed in them, to attach the cords to, they may not be liable to slip and come out. The intestines are now selected according to their size; and two or three of them are taken, and the ends twisted round one of the pegs first placed; and the other ends are carried to the opposite ones, and attached to them. Two turns of the intestines around the pegs are sufficient to prevent their slipping. When fixed to the pegs they must not be drawn tight; as they would be subject to snap during the twisting, if sufficient play were not given to them for that operation.

If any of the intestines should be found too short to reach the opposite side of the frame, they must be lengthened, by pieces cut off any others which may be too long; and care must be taken to make the ligature near the last placed peg, to preserve the cord of an equal size in its whole length; as otherwise it would be false in its tone.

The frame being filled up in the manner we have described, two or three of the pegs, bearing one end of the intestines, are fixed to the spindles, if the

machine contains several, and turned round several times; passing the finger and thumb of the left hand frequently from one end of the cord to the other, beginning at the spindle. When all the cords have undergone this operation, and the pegs are all replaced, the whole frame is placed in the sulphuring closet, with several others; as it would not be worth while to sulphur one at a time.

The sulphuring closet is placed in a damp place surrounded as much with water as possible. An earthen vessel, containing the sulphur, is placed in it, with the frames; the sulphur is then set on fire, and the closet well closed in every part, to confine the fumes. When the cords have remained a sufficient time—which, of course, varies in some measure according to circumstances—the frames are taken out, and placed on the *refresher*, and rubbed with a horse-hair cloth. This done, they are again placed in the frame, twisted anew, and returned to the sulphuring closet, to undergo the same process as before. If the state of the atmosphere require it, the whole of these processes must be twice or thrice repeated; and they are then left to dry.

When the cord is sufficiently dry; it is known by its not running up when a peg is taken out, and remaining stiff and straight, instead of flagging. If dry enough, they are well oiled with good olive oil and coiled up into rings for sale. They become better by being kept some time.

To make the fourth strings for violins, or any other sized cords, intended to be covered with metal-wire, the process is so well known, that it need not be here described.

The whole success of these operations depends principally on the ability and experience of the workman in managing the different washings, stretchings and twisting, and in a judicious use of the sulphur. When the cord is too much sulphured, it readily snaps; and on the contrary, when it is not enough so, it stretches too much, and never keeps in tune.

We may conclude, that there is no fixed rule yet adopted for the success of this branch of manufacture; but we have much expectation that we shall soon be able to succeed as well as the Italians.

PATENT GELATINE;

AS PREPARED BY MR. NELSON, THE PATENTEE.

Many of our readers must have seen a beautiful article exhibited for sale in some of the London shops called "Prepared Gelatine," and which is adapted for the making of jellies and soups—being nutritious, pure, and tasteless, until flavored according to the purpose for which it is intended. The method of manufacturing this excellent article, (for excellent it is), is described as follows by the Patentee:—

"When the cuttings of skins, parchment, &c., have been freed from hair, flesh, and fat, and washed clean in cold water, I score the grain side of them to the depth of about an eighth part of an inch, in lines about an inch apart in order to facilitate the action of the alkali which I use, and to render such action more uniform. I then macerate them in a caustic solution of alkali at a temperature of about 60 degrees Fahrenheit, using for this purpose brick vats, or vessels lined with cement in the ordinary manner, and these vats or vessels, which I call the macerating vessels, must be covered with lids excluding the general atmosphere; any vessels which are not acted upon by the alkali may be used. I thus macerate the cuttings until I can pass a fork or any other similar instrument through them with little resistance, and I generally find that they are sufficiently macerated in about ten days. The alkali which I prefer for my solution is soda, and I prepare my solution in the ordinary method, using three parts of the common soda of commerce, with two parts of fresh-burnt lime to sixteen parts water, or any quantity of fresh burnt lime sufficient to render the solution caustic may be used. When the process of maceration is sufficiently complete, as already pointed out, I remove the cuttings from the solution, put them in vessels similar to the macerating vessels, and which must also be covered with lime, excluding the general atmosphere, I leave them in such vessels thus covered until they have become sufficiently soft. It will be ascertained whether they have become sufficiently soft by passing a fork or other similar instrument through them, and when they have become sufficiently soft, the fork or other instrument will pass easily through them. Whilst the cuttings are thus left to become soft, they must be kept at a temperature between 60 and 70 degrees Fahrenheit, and as they become sufficiently soft as above pointed out, I remove them, and I slice or split such of the cuttings as are materially thicker than the others, in order to bring them to the same, or nearly the same, thickness. I then put the cuttings into wooden cylinders, placed in water vessels filled with clean cold water, but care must be taken not to put into any cylinder more than half the quantity which it is capable of containing. These cylinders, which I call washing cylinders, must be constructed in such manner as to allow water to pass freely through them, and they may be fitted in the water vessels in any convenient manner to allow of their revolving within such vessels. I secure the cuttings within these cylinders and then I cause the cylinders to revolve slowly in the water. I have found cylinders of three feet in diameter a convenient size, and I cause these to revolve at a speed of about one revolution in a minute. Whilst the washing cylinders are thus revolving, I cause a current of water to be kept up through each of the water vessels by means of an aperture at the bottom of the vessel at one end, and a pipe at the top of the opposite end, through which pipe clean cold water is continually supplied. I continue the cylinders revolving in a current of water, as I have described, until the alkali is sufficiently washed out of the cuttings, and I generally find six or seven days sufficient for this washing, when I use cuttings of ordinary thickness; but when I use cuttings which are thicker than these I continue the washing in proportion to the thickness of such cuttings. When the cuttings have been thus washed I remove them from the washing cylinders and place them in a wooden closet, constructed in the ordinary method to prevent the escape of gas, and there expose them to the direct action of sulphurous acid gas produced by the combustion of sulphur within the closet. I continue the cuttings thus exposed to the direct action of this gas, until they have a slight excess of acid, and I ascertain whether they have an excess of acid by testing them with litmus paper in the ordinary manner. I then remove them from the closet and press them by any ordinary means to separate as much water as possible; and after they have been thus pressed I put them into glazed earthenware

vessels, or any other vessels which are not acted upon by acid. I call these vessels steam-baths, and I apply steam to them in the manner usually employed for heating steam-baths, but any other convenient means of heating them may be used; I thus bring the cuttings to a temperature of about 150° Fahr., and I keep them at this temperature; by means of a suitable wooden intrument I stir or agitate them until they are almost entirely dissolved. The liquid thus formed is gelatine, and I separate it from the residiuum which remains undissolved by straining, and put it into vessels which I call settling vessels, and which are constructed in the same manner as the steam-baths. I heat these settling vessels in the manner which I have already pointed out for heating the steam-baths. Whilst this liquid gelatine is in these settling vessels it should be kept at a temperature between 100 and 120° Fahr., and I allow it to remain undisturbed in the settling vessels, for the purpose of clearing it, until I consider the impurities which it contains have sufficiently settled or subsided. I generally find nine hours sufficient for this purpose, but if the impurities have not sufficiently settled or subsided in that time, I prefer to clear it by straining it through a woollen cloth. I remove the liquid gelatine from the settling vessels by means of a syphon, but any other suitable means may be used for this purpose, and after it has been sufficiently cleared I pour it upon slabs, which I call cooling-slabs, to the depth of about half an inch. These slabs may be of stone or marble, but they must have frames of some convenient material, at least half an inch in depth fitted to their edges, and care should be taken to place the slabs in cool situations. I allow this gelatine to remain upon the slabs until it becomes cold and sets into a firm substance, and I then cut it into pieces, and wash these in the washing cylinders and water vessels which I have already described, in the same manner as I have already mentioned for that purpose in respect to the cutting, as I take them from the macerating vessels. This washing must be continued until the excess of acid is entirely, or nearly altogether removed from the gelatine, and I generally find that three days are sufficient for this purpose; but I ascertain whether the excess of acid has been removed by testing the gelatine with litmus paper in the ordinary manner. After the excess of acid has been removed, I take the gelatine from the cylinders and put it into the steam-baths, and then dissolve it by applying heat to the baths in the manner which I have already pointed out for that purpose; but it will be desirable to avoid raising the temperature of the gelatine above 85° Fahr. When the gelatine has been thus completely dissolved, I pour it again upon the cooling slabs, as before, and I allow it to remain until it becomes again cold, and sets into a firm substance. I then cut it into pieces and dry it upon netsby exposure to a current of cool dry air, when dried it is fit for use."

The gelatine of the second quality is prepared, without the aid of any alkaline solution, by steeping cuttings in a weak solution of sulphuric acid, or subjecting them to the direct action of sulphurous acid gas, until in either case they have imbibed "an excess of acid." After this they are kept in wooden barrels for three weeks, at a temperature of about 70°, and then put into a steam-bath and entirely dissolved. A liquid gelatine is then obtained, which is treated in the same manner as the liquid gelatine mentioned in the process before described, until it is completely dried and fit for use.

MISCELLANIES.

Tracing Paper.—Dissolve one ounce of powdered clear white rosin in 2 ounces of spirits of turpentine —then add 30 drops of the essence of lemons; shake it well for a few minutes. With a clean painter's tool, varnish a sheet of tissue paper with the compound; hang it up to dry for 30 or 40 minutes, then give the other side a coat with the same fluid. The tissue paper so prepared is beautifully transparent, and it will keep its appearance for years. The chief disadvantage is that it is apt to stick to the fingers when warm. Nut oil and Canada balsam applied hot, is for this reason superior; some persons use nut oil only.

To make Spruce Beer.—Put four gallons of boiling water into a tub or cask with four gallons of cold water, by which you will get the proper degree of heat; then add eight pounds of treacle, and two or three table spoonsful of the essence of spruce: stir these thoroughly well together, and add a quarter of a pint of good yeast. It is now to be kept in a temperate situation till the fermentation is somewhat abated, (which will be in about 48 hours), and then bottled off, when in two days it will be fit for use

Color produced in Plate Glass by the Sun's Rays.—"It is well known," Mr. Faraday remarks, "that certain pieces of plate glass acquire by degrees a purple tinge, and ultimately become of a comparatively deep color. The change is known to be gradual, but yet so rapid, as easily to be observed in the course of two or three years. Much of the plate glass which was put a few years back into some of the houses in Bridge Street, Blackfriars, though at first colorless, has now acquired a violet or purple color. Wishing to ascertain whether the sun's rays had any influence in producing this change, the following experiment was made:—Three pieces of plate glass were selected, which were judged capable of exhibiting this change; one of them was of a slight violet tint, the other two purple or pinkish, but the tint scarcely perceptible except by looking at the edges. They were each broken in two pieces; three of the pieces were then wrapped up in paper, and set aside in a dark place, and the corresponding pieces were exposed to air and sunshine. This was done in January, and in the middle of September they were examined. The pieces that were put away from light seemed to have undergone no change; those that were exposed to the sunbeams had increased in color considerably; the two paler the most, and that to such a degree, that it hardly would have been supposed they had once formed part of the same pieces of glass as those which had been set aside. Thus it appears that the sun's rays can exert chemical powers even on such a compact body and permanent a compound as glass."

QUERIES.

201—Why does a piece of bread neutralize the effects of pungent mustard?

202—Why is it that light passing through a green woollen blind appears pink?—*Answered on page* 415.

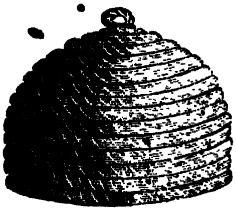
203—Why do liquids applied to wood cause it to appear darker than before?—*Answered on page* 415.

204—What will destroy the peculiar smell of naphtha?—*Answered on page* 415.

205—How is bread to be made without yeast?—*Answered on pages* 240 *and* 356.

206—What is the cause of some distilled spirits presenting a milky appearance when diluted with water? And by what means is this to be prevented?—*Answered on page* 415.

Fig. 1.



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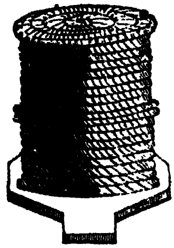

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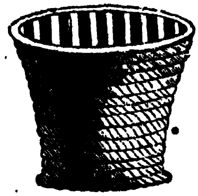


PRACTICAL MANAGEMENT OF BEES.

4. 6. 5.

PRACTICAL MANAGEMENT OF BEES.

In the practical management of bees, the formation and due arrangement of the apiary is of some importance. The prime requisites are *quiet and shelter* from the extremes of heat and cold. Facing southwards, the hives should be carefully screened from the north and north-east. A group of young trees, or a close-growing hedge, will answer the purpose well; or advantage may be taken of a range of buildings, or a garden-wall. In availing ourselves, however, of the shelter of buildings, care must be taken to keep the hives at such a distance as to be clear of the rain-drops, and from the eddying winds caused by such a locality. A distance of not less than eight or ten feet should intervene between them and the screen; and of this space the half-breadth next the hives should be laid with fine gravel, to absorb the moisture, and keep it free from weeds, grass, straws, &c. The space of ground between and in front of the hives, to the extent of at least three feet, should be covered in the same manner.

Quiet is essentially necessary to their doing well. Bees do not thrive in the near neighbourhood of incessant noise. The apiary, therefore, should be at a distance from smithies, mills, steam engines, &c., and also from such manufactories as emit noisome smells. When circumstances will admit of it, the apiary should be placed in view from the windows of the family sitting-room. This will save much of the trouble incurred in watching at swarming time, as well as give greater security from marauders. The hives should be elevated about fifteen inches from the ground, on a *single post* or pedestal, in preference to three or four, which is the usual number. Vermin are thus prevented by the projecting edge of the floor-board from climbing over and reaching the entrance. It may be laid down as a good rule to have the hives placed as far from one another as the extent of the apiary will admit. When standing at intervals of only two or three feet, the bees are very apt to quarrel amongst themselves. They sometimes mistake their own proper domiciles when too much crowded together, especially when hurrying homewards in the working season, or hastening to escape a shower, and the mistake is attended with fatal consequences. In feeding a weak hive, a close neighbourhood is particularly dangerous; the smell of the syrup is quickly diffused over the whole colony, and pillage generally ensues. In swarming, too, when the newly-departed emigrants are discouraged by a sudden blast or change of atmosphere, and the queen hastens to return to her old abode, her ignorance of the locality (she having, if a young queen, never been abroad before) renders her very apt to mistake and enter a hive where she is by no means welcome, and the swarm following her, a bloody conflict takes place.

When the apiary is situated in a garden, there will be no want of bushes and low-growing shrubs on which the bees may alight when swarming. But when it is located on a lawn or smooth level, the swarm is extremely apt to fly off altogether, or to take up its station on some high tree in the vicinity, from which it is difficult to dislodge it. A few ever-green shrubs growing in front of the hives, and at a few yards distance, will prevent this. Or if such an arrangement be, from particular circumstances, not expedient, the evil may be so far remedied by sticking into the ground, near the apiary, some branches of trees, retaining their foliage, about the period when swarming may be expected.

Water is essential to the operation of these insects during spring and summer; a shallow pebbly stream in the vicinity will, therefore, be most advantageous, where they can drink without danger of drowning. Its absence should be supplied by artificial means; and a shallow vessel of water placed in a secluded and quiet quarter of the apiary, having a few smooth stones thrown into it, of a size to project above the surface, and afford footing to the drinkers, will answer the end. The neighbourhood of large sheets of water, however, or of broad rivers, is injurious; the little foragers, in crossing during high winds or dashing rains, perish by hundreds in a single day.

Covered apiaries, or bee-houses, are common in England, and are, sometimes, though rarely, met with in Scotland; they have their advantages. but are not without serious drawbacks. They afford shelter from the extremes of heat and cold, and, when properly constructed, are also a complete protection from thieves. But when the number of hives is great, the expense of such structures is so considerable as to preclude entirely their being brought into common use. Besides, their confined limits render it necessary to place the hives quite close to one another—an arrangement which we have already noticed as a great evil. And, finally, in operating experimentally on any particular hive, the whole colony is apt to take the alarm, and to cause a degree of confusion most inconvenient to the operator.

A good thick coat of oat or rye-straw, if the hives be of that material, or if of timber, a well-seasoned and painted surtout of fir-plank, three-fourths of an inch in thickness, resting on the floor-board, and having a vacant space of an inch between it and the hive, will be quite sufficient security against the extremes of heat and cold, while rain may be warded off by thatching the hive, as is shown in Fig. 5.

Hives are found of almost all shapes and sizes, and of various materials—circumstances influenced sometimes by convenience, but oftener by the taste and fancy of the owners. In France, particularly, where the culture of the bee has been much attended to, the variety of hives is very great; but with few exceptions, they appear to be remarkably deficient in simplicity.

Straw Hives, of the common bell-shape, with all their imperfections, will continue in use, because they are easily made, and cost little—because the handling of them requires but little skill—and because, as long as the suffocating system is persisted in, they answer the purpose well enough. It would be desirable, however, that more pains were bestowed on their form. To concentrate the heat—to retain it, and thus to accelerate the hatching of the brood, on which so much depends, no shape is so well adapted as the globular. We would therefore recommend straw hives to be made in the form of a globe, having the third of its diameter cut away. (See Fig. 1.) Two rods or sticks of three-fourths of an inch in thickness, forced through the hive at right angles to a line drawn from the entrance, and about an inch higher up than the centre, will be sufficient to support the combs.

Wildman's Storied Straw Hive.—This is preferred by many to wooden hives on the same plan, from the persuasion that straw is a preferable material. It consists of two or more stories, each

seven inches in height, and ten inches in diameter. In the upper row of straw, there is a hoop of about half an inch in breadth, to which are fastened six or seven wooden spars, each one-fourth of an inch thick, and one inch and a quarter broad, and half an inch apart from each other. To these bars the bees fix their combs.

In order to give greater steadiness to the combs, and prevent their being broken or deranged when the hive is moved, a rod is run through the middle of it, in a direction across the bars, or at right angles with them. A flat cover of straw, worked of the same thickness as the hive, and twelve inches in diameter, is applied to the uppermost story, " made fast to the hive with a packing-needle and thread," and carefully luted. Before it is put on, a piece of clean paper, of the size of the top of the hive, should be laid over the bars, the design of which is to prevent the bees working in the intervening spaces. (See Fig. 2.)

Grecian Hive.—This has long been in use in the Greek Islands, and is sometimes called the Candiote Hive. It is in the form of a flower-pot, open at the top, and provided with a flat cover in the same manner as the hive last described. As in this last, also, a certain number of bars are fastened to the uppermost roll of straw, each designed for the foundation of a comb; and when prepared for use, the cover is laid above these bars, fixed at the edges by wooden pins, or sewed with pack-thread, and having the joining carefully plastered with clay. (See Fig 4.) This hive affords considerable facilities for forcing the bees to work in wax. It is only necessary to remove one or two of the combs, and the bees will immediately commence filling up the vacancies. In this way, a portion of their honied stores may be abstracted without difficulty, and without having recourse to the barbarous practice of suffocation. It affords also the means of making artificial swarms. It will be observed, that in consequence of the diameter of the hive gradually diminishing towards the bottom, rods inserted through the body of the hive are rendered unnecessary, the wedge-like form of the combs serving sufficiently to support them. " The hives," says Wheeler, in his *Journey into Greece*, " are made of willows or osiers, fashioned like our common dust-baskets, wide at top, and narrow at the bottom, and plastered with clay or loam within and without. The tops are covered with broad flat sticks, which are also plastered over with clay; and to secure them from the weather, they cover them with a tuft of straw as we do. Along each of these sticks, the bees fasten their combs; so that a comb may be taken out whole, and with the greatest ease imaginable. To increase them in spring-time (that is, to make artificial swarms) they divide them, first separating the sticks on which the combs and bees are fastened from one another with a knife; so taking out the first comb and bees together on each side, they put them into another basket in the same order as they were taken out, until they have equally divided them. After this, when they are both again accommodated with sticks and plaster, they set the new basket in place of the old one, and the old one in some new place. And all this they do in the middle of the day, at such time as the greatest part of the bees are abroad, who at their coming home, without much difficulty, by this means, divide themselves equally. In August, they take their honey; which they do in the day-time also, the bees being thereby, say they, disturbed the least; beginning at the outside, and so taking away, until they have left only such a quantity of combs in the middle as they judge will be sufficient to maintain the bees in winter; sweeping those bees that are on the combs into the basket again, and covering them anew with sticks and plaster."

Bee-Boxes.—The respective merits of *straw-hives* and *bee-boxes* have often been made the subject of discussion. Certainly those of straw have a decided superiority over those of wood, in respect to their capability of maintaining an equable temperature, from the non-conducting quality of the material of which the former are constructed. The latter are more easily kept clean—they furnish better means of defence against vermin—they are a great deal more durable, and afford a much greater facility for operating experimentally, and studying the nature of their interesting inmates. And what is always of importance in matter of rural economy, their cost, at least as regards the simpler kinds, is very little more than that of the straw hives; and if we take their durability into account, it is actually less. But the nature of the material of which they are made, rendering them easily affected by variations of the external temperature, furnishes an important and well-founded objection; for notwithstanding all the precautions used, no practicable or manageable thickness of material, nor wrappings of straw ropes and straw covers, have been found effectual in remedying this defect. Therefore, those who cultivate bees for the sake of their produce only, and who have no particular desire to study minutely their natural history, or to witness their proceedings in the interior of their dwellings, will do well to adhere to hives of straw. There is a greater variety of form and structure in the wooden hives, than in those of straw; but the storied kinds, of various dimensions, are most generally used. It is quite immaterial of what shape these boxes are, provided the safety of the bees, and the convenience of inspecting their operations and taking their honey, be at all times regarded in their construction. So, also, to describe even a small part of what are found so varied, would be at best imperfect and unsatisfactory. They may be made of a single box, as represented in Fig. 4, or consist of a greater number united as in Fig. 6. Though to the latter construction, is the same objection as that made to the too close approximation of hives of any kind. Some part of a wooden hive should at all times consist of a glass window, covered, however, on the outside with a shutter; the use of this window is to enable the master to inspect the inside of the hive, that he may judge of its state, as to its fulness, and the health, activity, and swarming of its inmates.

RESEARCHES ON CHARCOAL.

BY M. CHEUVREUSSE.

Men of science, both ancient and modern, have published a great number of works on the properties of charcoal, and notwithstanding the extent of their researches, the most of their labours are incomplete.

In considering charcoal with respect to electricity, they have remarked that some charcoals give a free passage to that fluid, while others refuse to transmit it; but they have not analysed the circumstances of this phenomenon.

On the other hand, charcoals have been regarded in general as bad conductors of caloric; never-

theless, experience shows that that there is a great difference between them in this respect.

If the labours undertaken on the hygrometric properties of charcoal are examined, it will be seen that they have not been pursued.

The combustibility of charcoal has been studied; but the results presented leave much to be desired. The state of imperfection in which our knowledge of charcoal is found, at present, has led me to submit the properties of this combustible body to a new examination.

Charcoal may be found in two states relative to its faculty of conducting electricity; the same takes place with regard to its power of conducting caloric, and the same sort which conducts electricity likewise conducts caloric.

Finally, charcoal from the same piece of wood will be found more or less combustible, according to its state of carbonization.

Carbonization.—If two pieces of wood, produced by the same branch, be taken and submitted to distillation in a retort of stone-ware or porcelain, until no more vapours pass off, two pieces of charcoal will be produced of the same nature, and in the same state of carbonization.

If, after this first carbonization, one of the pieces of charcoal be replaced in the retort, and be heated to redness, from these two operations two pieces of charcoal will be obtained, which will possess very different properties.

All sorts of light and heavy wood that could be procured, both native and foreign, submitted to these two distillations, have given charcoals which presented the same differences.

Charcoals from animal substances, produced by a first distillation, could not be made to change their state but by a violent degree of fire.

To change the property of vegetable charcoal, it was sufficient to make the fire red; the method of applying the heat is indifferent. Whether the operation is performed in close vessels, or in the open air, the result is the same. If it is effected by ignition, the mode of extinction is equally indifferent.

In general, charcoal may be found in two opposite states, resulting from the intensity of the heat which has been applied to them during their preparation.

Conductibility for Electricity.—It has been long since remarked, that among charcoals some had the property of transmitting the electric fluid, but the study of the circumstances which accompanied this faculty has been neglected.

In the experiments which I am going to recite, all the charcoals in their first state of carbonization, and which are newly prepared or dried, do not conduct electricity, and they do not become conductors but when they have undergone the action of a strong fire.

A fact which it is important to notice is, that the charcoal which is not a conductor does not develope electricity by its contact with zinc or iron, and when it is a conductor, it produces electricity by this contact.

The conducting property of a charcoal for electricity may therefore be varied by the contact of zinc or of iron; and this simple method is even preferable to others, since, if the non-conducting charcoals are humid, they transmit electricity; wherefore the application of one of these two metals, and principally of zinc, will be the method which we will use to ascertain the state of conductibility of a charcoal for electricity.

If charcoal which is to be examined is in a state of powder, it may be made into a paste with gum water, and a tablet may be obtained which may be tried with facility. The only precaution to be taken is, not to add more of the mucilage than is necessary for making the paste.

To a charcoal in the first state of carbonization, the faculty of conducting the electric fluid at one of its points may be given, by making this point red-hot. This experiment is easily performed by heating a small cylinder of charcoal at the flame of a candle; when it becomes red, it is to be dipped in water. If it is then tried, it will be perceived to have become a conductor of electricity.

The best conducting charcoals which I have as yet been able to meet with, are those which have escaped combustion during the reduction of ore in the high furnace, and which are drawn out along with the slag.

From these results we may range all these charcoals into two great classes—charcoals that are conductors of electricity, and charcoals which are non-conductors.

Conductibility for Caloric.—Nothing has yet been published on the conductibilty of caloric; and this combustible body having been known to present the greatest resistance to this fluid, has been named a *bad conductor*. This error has arisen from its having been believed that charcoal only existed in one state; but the experiments which follow prove that some charcoals refuse to conduct caloric, while others transmit it with sufficient facility; and it is extremely remarkable, that the charcoals which are conductors of electricity are also equally conductors of caloric.

If a piece of charcoal be chosen without cracks, and without knots, of a cylindrical form, about three lines in diameter, in the first state of carbonization, and that one of its extremities be exposed to the flame of a candle, the heated part will enter into combustion, and the propagation of the heat will not be sensibly extended beyond the part immersed in the flame.

If the same operation is repeated with a cylinder of charcoal, taken from the same wood, in the second state, and consequently a conductor of electricity, the effects which will be observed will be different: the caloric will be immediately transmitted from one end of it to the other, and the sensation of heat will become so great that fingers of any delicacy would be unable to hold the charcoal in the experiment. The extremity placed in the flame will moreover be observed to grow red, and not to burn in so decided a manner as in the first case.

The theory had before pointed out that the effects observed should thus take place: in the first experiment the accumulation of the caloric increased the ignition; and in the second, its transmission opposed the inflammation.

These simple experiments may show the difference of conductibility between the two sorts of charcoal; but as they do not seem sufficient for naturalists accustomed to the most scrupulous researches, I have made use of the little apparatus which I am going to describe.

To make this experiment, a vessel of earthenware or of wood may be used, the sides of which are of equal thickness. These sides should be pierced with two holes, from 0.015 metre to 0.020 in diameter, for the reception of two charcoals of the same dimensions, the length of which should be exactly

equal, and which should only differ in their state of carbonization.

The external extremity of each of these charcoals should be hollowed, to receive the bulb of a thermometer, which should be kept in contact with it, and should be supported in a horizontal position. The vessel should then be filled with mercury, the temperature of which should be near ebullition.

The result of this disposition must be, that the two charcoals would be in the same circumstances, since their interior extremities are exposed to the same source of caloric.

In one of the experiments made with this apparatus, on employing two charcoals of poplar, one in the first state of carbonization, and the other in the second; and on using two thermometers marking 20°, (Reaumur) before the operation, I observed that the thermometer applied to charcoal in the second state, rose rapidly from the instant that the vessel was filled with mercury, whilst the other was stationary, and that a few instants afterwards it indicated 38°, that of the charcoal in the first state of carbonization being still at 23°, that is to say 15° below the first.

The thermometer, lodged on the charcoal in the second state of carbonization, arrived to its *maximum* of 40°, while the other, after a long interval of time, did not rise beyond 25°.

This last experiment leaves no doubt respecting the difference of conductibility of the two charcoals for caloric; and it proves besides, that the charcoals which are conductors of electricity, are equally conductors of caloric.

Density.—It is known that the specific gravity of charcoals in general arises according to the density of the wood from which they are made; but in the course of my experiments I have always remarked, that those of equal weight in the first state of carbonization had constantly a greater bulk than those in the second state, that is to say, which had been prepared in the contrary circumstances.

To verify this first perception, I examined the density of charcoal of black alder in their two states. To effect this design, I weighed equal volumes of the charcoals, divided to the same thickness, and in the two states of carbonification already recited, and found that the density of the charcoal of black alder, in the first state of carbonization, is to that of the charcoal of the same wood in the second state, as 4 is to 3.

I then took charcoals of the extreme limits of density afforded by those in my possession, that is to say, poplar and guaiacum; the woods of which had for their respective densities 0.3042 and 1.3132; but instead of weighing them after I had pulverized them, as in the first case, I took their weight in air and in water, in determining the quantity that they absorbed of the latter, and I then obtained the following results:—

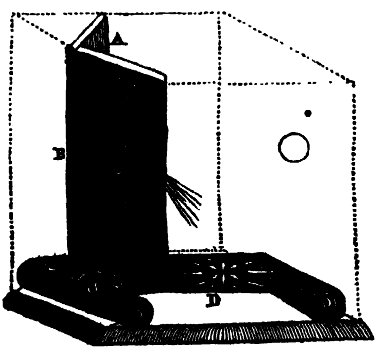
Charcoal of poplar—	1st carbonization	0.12372
	2d carbonization	0.18743
Charcoal of guaiacum—	1st carbonization	0.68178
	2d carbonization	0.84829

From this table the consequence may be drawn, that of light wood, that of poplar for example, the charcoal in the first state of carbonization has a density two-thirds of that of charcoal in the second state of carbonization; whilst for the more compact woods such as that of guaiacum, the density of the charcoal in the first state is a little above three-fourths of that of the charcoal in the second state. These experiments prove, moreover, that charcoals prepared from the same wood may be, with regard to their density, distinguished into two classes, and that the most dense charcoals are those which are conductors of electricity and of caloric.

THE MYRIAMOSCOPE.

Is a modification of that well-known instrument, the Kaleidoscope. Although the latter produces the most beautiful patterns imaginable, yet on the slightest shake (which can hardly be avoided), its reflections vanish in a moment, never more to be seen, to the great mortification of the artist who may be endeavouring to copy its Protean shapes, and the instrument in its present state is little better than an optical toy. If some means could be adopted to throw its beautiful figures on a screen, after the manner of a magic lanthorn, it would then furnish designs, *ad infinitum*, of the greatest use to carpet manufacturers, &c. This is accomplished by the myriamoscope, which is thus constructed:—

Procure two pieces of looking-glass of the same size, A A, join them together as at B, with a strip of leather, which will act as a hinge, so that the mirrors may be put to any angle required. Place two rollers beneath, on which affix a piece of calico, D, which may be rolled off one and on to the other by means of two knobs or other contrivance. On the calico paste ornaments of various descriptions: those beautiful borders and flowers furnished by paper-hangers are very suitable. It is evident that whatever objects may come in contact with the mirror, will according to their inclination form the most beautiful designs. A small fragment of an ornament will form a centre-piece, and a part by reflection will produce a whole.



The mirrors should be so adapted that they may be put to any degree of inclination, by means of two small strips of wood affixed to them and reaching through the sides of the box. The top of the box may be in part covered with a piece of muslin, or some semi-transparent substance, in order to admit the light, and an aperture should be made in the box to receive the objects.

LITHOGRAPHY.

Lithography is founded on mutual and chemical affinities, which hitherto had never been applied to the art of engraving. The dislike which water has for all fat bodies, and the affinity which all compact calcareous stones have both for water and greasy substances, are the bases on which rests this highly

interesting art. The art of lithography may be divided into two parts: 1. The execution of the drawing; 2. The printing. The former requires but little practice, as any person who understands drawing may meet with succes; the latter is filled with difficulties.

The first part consists in drawing on a stone (which has been previously made perfectly level and smooth) with an ink or chalk composed of greasy materials, in the same way one would execute a drawing on paper with ink or common chalk: the second consists in taking the stone, as received from the draftsman's hands, and obtaining impressions from it, as one would from a copper plate. To obtain these impressions, the lithographic printer wets the whole surface of the stone; but as the greasy chalk, which constitutes the drawing, has a natural aversion for water, those parts of the stone alone which are not covered with the chalk imbibe it. The printer, while the stone is still wet, passes a thick and greasy ink over its whole surface, and the greasy lines of the drawing receive the ink, while the wet surface of the stone refuses to take it: a sheet of paper is now strongly pressed on the stone, which, receiving the printing ink that has been applied to the drawing, gives a reversed fac-simile of the original one: the stone is wetted afresh, again charged with ink, and thus a series of impressions are obtained.

In the above description consists the whole art of lithography.

The same result is obtained as in printing from a copper plate, but by different means: the process of engraving is entirely mechanical, that of lithography entirely chemical.

Composition of Ink.—This has been prepared with grease, mixed with essence of turpentine, and with resins dissolved in spirits of wine: the preference is, however, given to greasy and resinous substances, combined with alkalies. Amongst the numberless recipes for making lithographic ink, the following appears to be one of the best:

Tallow candle,	2 ounces.
White wax,	2 ounces.
Shell-lac,	2 ounces.
Common soap,	2 ounces.
Lamp-black.	

Soap is the only one of the above components of which the proportion must never vary; it is destined, by the alkali which it contains, to render the other ingredients soluble in water.

It is necessary, in order to mix the above ingredients, to have an iron saucepan, with a cover that closes hermetically. The wax and the tallow must be put in, and heated until they catch fire; while they are burning, the soap (which has been previously cut into small bits) must be thrown in separately, and stirred the whole time; but a new piece must not be thrown in before the former are melted. The whole of the soap being dissolved, they are allowed to burn until reduced to the volume they had before the soap was put in: great care, however, must be taken not to burn it too much. The shell-lac is now added, and the flame extinguished, if it has been possible to keep it lighted during the whole operation, as it is often necessary to extinguish it in the beginning, and take the saucepan off the fire, to hinder the contents from boiling over. The flame being once put out, if all the substances are not completely melted, they must be dissolved by simple ebullition.

A small quantity may now be put on a cold plate; if it works between the fingers like wax, it must be burnt a little more; but if, after it is quite cold, it is broken in two, and the bits will not join on being pressed with the fingers, about a dram of soap must be added to the mass in the saucepan, and, the moment it is dissolved, the flame put out.

If, when cold, a piece of this ink is dissolved with water in a saucer, by rubbing, as one would Indian ink; although at first it appears but little inclined to dissolve, it will at last unite with the water, and form a greyish and slimy liquor.

The ink brought to this state of perfection, put the saucepan upon a slow fire, and add some fine lamp-black: it will now be observed, that the more black there is put in, the more soluble in water the ink will be. Too much black, however, would spoil it; enough only is sufficient to make it black, instead of the light brown or greyish color which it had before the black was put in.

The ink is at length perfect; and may either be cast in paper cylinders, similar to cartridges, or on a slab of marble (previously rubbed with soap); and, when it begins to cool, compressed by another piece of marble or stone laid upon it; it is lastly cut into square bits, like Indian ink. This composition is of the highest importance to ensure the success of the drawings executed in ink. It must be similar to Indian ink, from which it differs only in weight and hardness, but of which it must have the fracture, the brilliant appearance, and solubility in water. In case the manipulation has not been completely successful, the following are the means of correction:—

To Remedy Defects of the Ink.—The ink is not soluble.—Add soap.

It is soft, and attaches itself to the fingers.—Burn it more.

Some time after dissolving it in water, it becomes thick and slimy, and requires a continual addition of water in order to be enabled to draw with it.—This is the defect of almost all inks; it proceeds from its being insufficiently burned.—Burn it more.

The ink is not compact, and is full of bubbles.—It has been cast too hot on the marble slab.—Cast it again when it is less hot, and lay a heavier stone over it.

The ink has no tenacity: it seems composed of scorias.—Both these defects proceed either from its being too much burnt, or from its containing too much black; in either case, add equal portions of wax and soap, and melt on a slow fire.

In all this manipulation, it is sufficient to have been informed of the qualities requisite to constitute good ink; and that the reader should remember that, unless the contents of the saucepan be burnt to a coal, the composition cannot be spoiled; and that it is sufficient to add more or less wax and soap, or burn more or less, according to the judgment of the person, and the state of the ink, to be sure of ultimate success.

Composition of Lithographic Chalk.—Chalk, to be of a good quality, must be firm, without being hard, and must attach itself to the stone without clogging. The cuttings of the chalk must form themselves into spirals, like wood shavings, and the texture must be close and homogeneous, like that of wax.

The composition of chalk is still more arbitrary than that of ink: more or less soap, wax, or tallow, may be added at pleasure, as more or less calcination may render these different proportions of little

importance; and, as the effect of the calcination in a given time varies, according to the intensity of the flame, it is preferable to indicate, as we have done for the ink, the different defects that chalk may have, and the remedy. The reader may easily imagine that it is impossible to give certain rules for making chalk, when he is assured that it is very difficult, even with great practice, to make twice following the same chalk: there is always some light difference.

Chalks have been made with bitumen and mastics, but they were friable, and did not adhere to the stone; an addition of wax was found necessary to bind the ingredients together. It must be confessed, however, that the chalk hitherto employed in lithography is far from being perfect; it generally has the defect of being too soft in summer. It is very important to keep the chalk in bottles with glass stoppers, as the least damp alters the nature of it.

Common soap,	1 ounce and a half.
Tallow,	2 ounces.
White wax,	2 ounces and a half.
Shell-lac,	1 ounce.

The manipulation of the chalk is in every respect similar to that of the ink, with the only difference that a few drams of wax (instead of the bits of soap) are thrown in, at the end of the operation. The burning must be stopped as soon as the chalk, when quite cold, breaks with a sharp and clean fracture, and resists strongly the pressure of the fingers. Less black is put in the chalk than in the ink; it is quite sufficient that the chalk should mark easily on the stone.

If the chalk is too soft, it must be burnt again; if too brittle, a little more wax must be added; if filled with bubbles, it must be cast hot on a marble slab, ground with a muller, and melted again with a gentle heat; lastly, it must be cast in a mould, in which it must be strongly pressed; for the heat of the fire expands considerably the composition, and, were not this precaution taken, it might still be filled with pores which would destroy its compactness.

If a mould cannot be procured, the chalk may be cast in a small linen bag, previously lined with some paper well rubbed with soap; it must then be well pressed with a weight or stone placed over it. The chalk must be taken out of the bag before it is quite cold, and cut in bits of a proper shape, either with a mould or knife and ruler.

(Continued on page 109.)

ACTION OF WATER ON MELTED GLASS.

Mr. Parkes, in his Essays, had adverted to some appearances produced by water flung upon glass when in the furnace, which appear extremely strange, although they were related to him by the most undisputed authorities.

If a small quantity, even a pint of water, were to be thrown into a crucible of glass in a melted, or rather melting state, while the scum or sandiver is upon its surface, the water would be converted instantly into steam, so that an explosion would take place; and if the quantity of water were more considerable, the furnace would probably be blown down.

But when the sandiver has been scummed off, and the glass is in quiet fusion, if water is thrown on it, the globules dance upon the surface of the melted glass, for a considerable time, like so many globules of quicksilver upon a drum-head wihle the drummer is beating it.

There is, however, a similar appearance to this that takes place in iron; for water evaporates sooner from a plate of iron that is heated to redness only, than from a plate that has been brought to a welding heat, or very nearly to a heat necessary to melt it.

But in the manufacture of black bottles, it frequently happens that while the workmen are employed in moulding and blowing the bottles, the glass, or metal, as it is called, becomes too cold to work, so that they find it necessary to desire the firemen to throw in coal and increase the heat.

This, however carefully it may be done, will sometimes produce so much dust that the surface of the glass becomes covered with coal-dust. When this accident occurs, it occasions such a motion within the melting pot, that the glass appears as if it were actually boiling; and if the metal was used in that state, every bottle would be speckled throughout and full of air bubbles.

Now, as it would be very inconvenient to wait for the whole of this coaly dust to be consumed by the fire; and besides, it might occasion the glass to boil over the edges of the melting, the workmen have to discover an easy and effectual remedy for this accident, and this remedy is no other than common water.

Whenever this circumstance takes place, the workmen throw a little water into each of the melting pots. This water has the effect not only of stilling the boiling of the glass immediately, but it also renders the melted metal as smooth and pure as before.

Mr. Parkes considers this curious and almost instantaneous effect, as probably owing to the water becoming decomposed, and affording its oxygen to the coal-dust, and thus converting it into carbonic acid gas, which immediately escapes, and is dissipated in the atmosphere.

COLORS FOR PAINTING ON VELVET, SATIN, SILK, &c.

Menstrum.—Dissolve three or four pieces of gum tragacanth in a teacup-full of hot water—strain, and add a little of this to the colors, when you lighten them for a first coat or ground-work, otherwise the colors will run.

Orange.—Pour one ounce of distilled vinegar on a small quantity of hay-saffron. When the color is extracted, pour it off clear—add gum-water when used. This color does not keep brilliant more than ten days in its liquid state, therefore make only a little at a time.

Golden Yellow.—Turmeric root one ounce, gamboge one drachm, rectified spirits of wine, one ounce and a half—digest in a warm situation for three or four days, then strain it.

Leaf Yellow.—French berries bruised one ounce, water three ounces—boil over a slow fire, until reduced to one ounce and a half. A few minutes before it is removed from the fire, add one drachm of finely powdered alum. When cold, strain and bottle it.

Scarlet.—Mix as much of the orange color with the pink saucer as may be necessary to produce a rich scarlet.

Rose—may be made to any shade, adding more or less lemon-juice to the pink saucer; a diluted solution of citric acid in water will answer the same purpose.

Crimson.—Lay a coat of pink saucer, very deep, on your intended crimson flowers, and afterwards a coat of carmine.

Carmine Liquid.—Carmine ten grains, liquid ammonia ten drops, distilled water one ounce—shake frequently, it is fit for use in twenty minutes.

Dark Purple.—Liquid archil half an ounce, twenty drops saturated solution of pearlash, and five grains of powdered alum—shake the ingredients well together in a bottle.

Light Purple.—Decoction of logwood half an ounce, powdered alum five grains—mixed.

Lilac.—Same as purple, but made much lighter with gum-water.

Brown.—Vary the tints by adding either black, carmine orange, or leaf-yellow. An infusion of Spanish liquorice, or tobacco, makes an excellent brown.

Drab.—Mix a small quantity of Indian ink, with leaf-yellow.

Grey.—Indian ink and blue, diluted with gum-water.

Black.—Indian ink.

Green.—Vary the tints of green by adding blue or leaf-yellow, as required.

Sap Green.—Used in its raw state.

Verdigris Green.—French verdigris one ounce, distilled vinegar, four ounces—boil for a few minutes over a slow fire, then add one drachm of cream of tartar—when cold, filter and bottle for use.

Blue.—Prussian blue powdered one drachm, oxalic acid one drachm, distilled water eight ounces—it is incompatible with the other colors, but it forms a beautiful ink or stain, without any color.

The pink saucer here spoken of is a decoction of carthamus, and is used in dyeing, and ordinarily sold in the shops, deposited as a pink powder in small saucers—hence its popular name. It is not a permanent color.

SINGULAR APPLICATION OF HEAT.

Some years ago it was observed, at the *Conservatoire des Arts et Metiers* at Paris, that the two side-walls of a gallery were receding from each other, being pressed outwards by the weight of the roof and floors. Several holes were made in each of the walls, opposite to one another, and at equal distances, through which strong iron bars were introduced, so as to traverse the chamber. Their ends outside of the wall were furnished with thick iron discs, firmly screwed on. These were sufficient to retain the walls in their actual position. But to bring them nearer together would have surpassed every effort of human strength. All the alternate bars of the series were now heated at once by lamps, in consequence of which they were elongated. The exterior discs being thus freed from contact of the walls, permitted them to be advanced farther, on the screwed ends of the bars. On removing the lamps, the bars cooled, contracted, and drew in the opposite walls. The other bars became in consequence loose at their extremities, and permitted their end plates to be further screwed on. The first series of bars being again heated, the above process was repeated in each of its steps. By a succession of these experiments they restored the walls to the perpendicular position; and could easily have reversed their curvature inwards, if they had chosen. The gallery still exists, with its bars, to attest the ingenuity of its preserver, M. Molard.

MISCELLANIES.

Steam Boilers.—A gold medal was recently decreed to the elder M. Chaussenot, by the Society for the encouragement of National Industry, for an apparatus to render the explosion of steam-boilers impossible. His invention is said to be perfect, both as regards its improvements on the safety-valve, and an ingenious contrivance to give due notice of danger to the crew: while in the event of all the warnings of the machinery failing, or being disregarded, the steam flows back upon the furnace, and instantly extinguishes the fire.

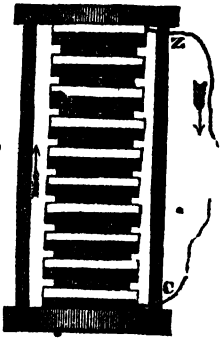
Fire Escape.—An exhibition of a newly-invented fire escape took place a few days since, in the inner yard of the workhouse of St. James, Westminster, in the presence of a number of the churchwardens and overseers of the various metropolitan parishes, and other gentlemen. The escape in question is the invention of Mr. Hawkins, of Vigo Street, Regent Street, Cashier to the County Fire Office; and is certainly the most simple we have yet witnessed, its portability being greatly in its favor. It consists of three ropes, each 60 feet long, which may easily be carried by the police, the weight being only eight pounds and a half; and on the occurrence of a fire, one of these ropes being taken to an up-stairs window of the house on each side of that on fire, and the end, at which is a spring joint, thrown into the street—both can be joined with the third left below. An elastic belt was also added to the screws, which several persons passing under their arms descended from the windows of the second floor, with the greatest ease and safety—*three* having been brought down in the space of *two minutes.* A basket, or open bag, for the rescue of females or children, can also be attached to it, and their descent effected with perfect safety. The exhibition appeared to give the highest satisfaction to all who witnessed it, and the churchwardens of St. James's immediately directed Mr. Hawkins to leave one for the use of that establishment.

Porcelain Letters.—These are intended to supersede the ordinary wooden letters fixed upon the facia of shop-windows, &c. They are of every color, and the golden ones are particularly beautiful. They are cleansed most easily with a sponge, and will shortly arrive from the manufactory in Staffordshire.

To make Gold Shells, or Liquid Gold for Printing.—Grind on a slab, leaf-gold with stiff gum-water, or honey, very fine, adding as you proceed more of the gum-water or honey, as you deem necessary. When the gold is reduced to an impalpable powder wash it in a large muscle-shell, with rain or distilled water, then temper it with a little of the chloride of mercury; fix it to the shell with a solution of gum arabic in which has been dissolved a small bit of lump sugar. Spread the gold evenly over the surface of the shell and dry it. When used, it is with plain water only.

Silver Shells, or Liquid Silver.—Process the same as the above—tempered in using, with white of eggs, instead of water.

Fig. 1.



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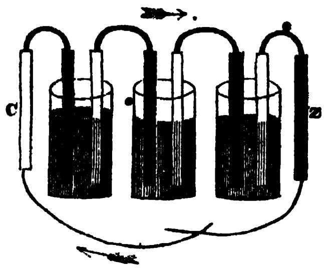

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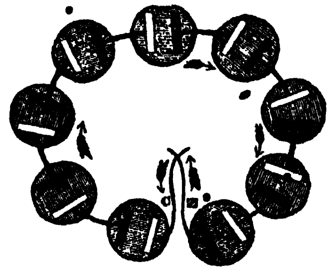

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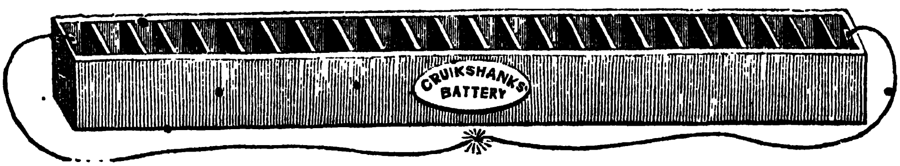
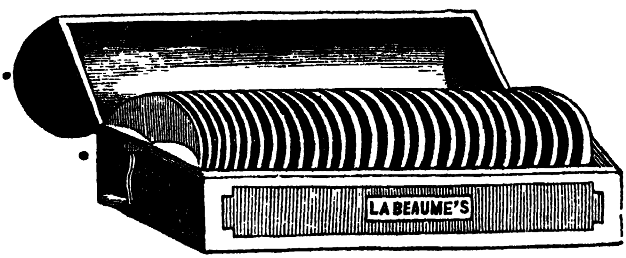


GALVANIC APPARATUS—BATTERIES.



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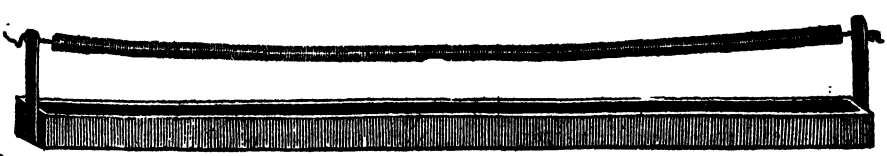


GALVANIC APPARATUS.—BATTERIES.

(Resumed from page 74.)

Our last paper on this subject considered the simple galvanic circles, without a reference to any continued series of such circles, and although we have described, in numerous papers introduced in former parts of this Magazine, the effect and application of such simple elements in producing certain surprising effects (the electro-type, for example), yet it is in the repetition of these causes, and the accumulation of these galvanic circles, forming what is called a galvanic battery, that enable us to witness this wonderful science in its full powers, and to judge of its mighty influence over animate and inanimate nature. The following is a plain description of some galvanic batteries in the order in which they were invented:—

The first of these is called the Voltaic Pile (Fig. 1.), which name equally expresses the name of the inventor and the shape of the instrument. M. Volta naturally concluded that if one pair of plates produced a certain effect, two pair would produce a greater degree of force, and so on. To confirm the supposition he procured some pieces of zinc, and some of silver, each as big as penny-pieces, and also some pieces of flannel somewhat smaller; these he piled up, first putting a piece of silver, then a piece of zinc, then a piece of flannel, wetted with water; again silver, zinc, flannel, and so on in regular order till some considerable number were piled up—having a wire at the top, and another at the bottom of this pile, and passing the wires through the limbs of a frog, as in the simple experiments, he found the muscles infinitely more acted upon than by a simple pair of plates. Also he found that when a pile of 40 or 50 pair had been made, that if he wetted a finger of each hand and held the wire himself, he felt a slight shock in the fingers, thus establishing the first grand and important fact as to accumulating the fluid. Subsequent experiments showed that when the flannel was soaked in salt and water, instead of water only, the effect was stronger—and still more so when a diluted acid was used.

During all the period of arranging the pile, galvanic action is going on, the surface of the metals becoming tarnished, and the acid becoming expended. Thus the pile has many inconveniences, besides the trouble of building it up—hence the substitution of other contrivances. The first suggested was the *Corronne de Tasses*, as represented in Figs. 2 and 3. Fig. 2, representing a side view of the series, holding a diluted acid, and containing each of them on the one side a slip of zinc and a piece of copper, so that the zinc of one cell is soldered to the copper of the next, and that in every cup the liquid divides the metals. Fig, 3 shows the section and general arrangement of these cups seen end-wise. This was, like the former, the invention of M. Volta.

The next great improvement was that of the Trough Battery, invented by Mr. Cruikshanks. It consists of a square box, formed of baked wood, and having a number of grooves cut in the sides and bottom, about half through the wood. In these grooves are fitted double metallic plates, formed of equal-sized pieces of zinc and copper soldered together at the top, and just large enough to slide into the grooves made to receive them, and tall enough to reach to about an inch from the top of the box. They are fastened in with common electrical cement. made of rosin, bees' wax, (one fourth part) and red ochre, in the following manner:—Make the box and plates quite hot, and have the box empty, and the plates near at hand. Then pour into the bottom of the box some of the cement, so as to cover it a quarter of an inch deep, and immediately afterwards put in as fast as possible, that is, while the whole remains hot, the plates, one in each groove, and be careful to press them to the bottom of the box. This being done, let the whole remain till so cold that the wax at the bottom is set —then lay the box on its side, have a little slip of wood to extend from end to end, so that the cement poured in shall run down between the various plates, and not be spilled by running out. Pour in a sufficient quantity of the cement and let it get cold, then turning the trough over fill up the other side in a similar manner, the trough will be complete, and the plates all fastened.

The plates are usually put half an inch or more apart, but this occasions great loss of power; they should be as close as possible together, not merely for the above reason, but because the trough is then more portable and requires less acid to fill it. Sulphuric acid and water is usually employed when troughs are made use of. They are convenient in practice, but liable to be injured by the warping of the wood, and the breaking of the cement—thus impairing the insulation of the cells.

Deferring till the next paper the description and comparison of more modern arrangements, we will notice two batteries invented by Le Beaume, for the purposes of medical galvanism. Neither of them, however, ever obtained any celebrity, nor can they be considered any longer of utility for any purposes, as the excellent coil apparatus of Mr. Bachoffner has superseded every previous instrument for medical galvanic uses.

Figure 5 presents a mahogany box, with the upper half formed like a lid. In this box are fitted a series of round double plates, fixed on an axis—the box is furnished with divisions of glass, and the plates turn round, a pair in each cell—thus the galvanic power is generated. It is conveyed by a wire from each end of the battery, as in other instances, to the patient or object which is to be galvanized.

Fig. 6 is an extensive series of metallic double plates, as before, not strung upon a cord. They are when in use suspended on two supports projecting above the ends of a long plain box—when to be used, the box is filled with dilute acid and water, and the plates are to be let down into it, when the galvanic action ensues, or rather is said to ensue, for as there are no divisions in the box to insulate each particular pair of plates, the action of the whole is very problematical.

(Continued on pages 141 and 266.)

ON MADDER AS A DYE DRUG.

Madder, a substance very extensively employed in dyeing, is the root of the ***rubia tintorum***, placed by Linné in his class and order tetandria monogynia; and by Jussieu, in his family rubiaceæ, named from this plant.

Although madder will grow both in a stiff clayey soil and in sand, it succeeds better in a moderately rich, soft, and somewhat sandy soil; it is cultivated in many of the provinces of France—in Alsace, Normandy, and Provence. The best European growth is that which comes from Zealand. Although often attempted to be grown in England, its cultivation has not succeeded here.

The best roots are about the thickness of a goose-quill, or at most of the little finger: they are semi-transparent, and of a reddish color, with a strong smell; the bark is smooth. Hellot ascribes the superiority of the madder which comes from the Levant to the circumstance of its being dried in the open air.

The red coloring matter of madder may be dissolved in alcohol, and on evaporation a residuum of a deep red is left. Fixed alkali forms in this solution a violet, the sulphuric acid a fawn colored, and the sulphate of potash a fine red precipitate. Precipitates of various shades may be obtained by alum, nitre, chalk, sugar of lead, and the muriate of iron. The quantity of oxy-muriatic acid required to destroy the color of a decoction of madder is double what is necessary to destroy that of a decoction of an equal weight of Brazil wood.

Wool would receive from madder only a perishable dye, if the coloring particles were not fixed by a base which occasions them to combine with the stuff more intimately, and which in some measure defends them from the destructive influence of the air. For this purpose, the woollen stuffs are first boiled for two or three hours with alum and tartar; after which they are left to drain: they are then slightly wrung, put into a little bag, and carried into a cool place, where they are suffered to remain for some days. The quantity of alum and tartar, as well as their proportions, vary much in different manufactories. Hellot recommends five ounces of alum, and one ounce of tartar, to each pound of wool. If the proportion of tartar be increased to a certain degree, instead of a red, a deep and durable cinnamon color is produced; because, as we have seen, acids have a tendency to give a yellow tinge to the coloring particles of madder. Berthollet found that by employing one-half tartar, the color sensibly bordered more on the cinnamon than when the proportion was only one-fourth of the alum.

In dyeing with madder, the bath must not be permitted to boil, because that degree of heat would dissolve the fawn-colored particles, which are less soluble than the red, and the color would be different from that which we wish to obtain. The quantity of madder which Mr. Poener employs is only one-third of the weight of the wool, and Schæffer advises only one-fourth. If wool be boiled for two hours with one-fourth of copperas, *i. e.* green vitriol, then washed, and afterwards put into cold water, with one-fourth of madder, and then boiled for an hour, a coffee-color is produced. Bergman adds, that if the wool has not been soaked, and if it be dyed with one part of copperas, and two of madder, the brown obtained borders upon a red. Berthollet employs a solution of tin in various ways, both in the preparation and in the maddering of cloth. He used different solutions of tin, and found that the tint was always more yellow or fawn-colored, though sometimes brighter than that obtained by the common process.

Mr. Guhliche describes a process for dyeing silk with madder:—For each pound of silk, he orders a bath of four ounces of alum and one ounce of a solution of tin; the liquor is to be left to settle, when it is to be decanted, and the silk carefully soaked in it, and left for twelve hours; and after this preparation, it is to be immersed in a bath containing half a pound of madder, softened by boiling with an infusion of galls in white wine; this bath is to be kept moderately hot for an hour, after which it is to be made to boil for two minutes.

When taken from the bath, the silk is to be washed in a stream of water, and dried in the sun. Mr. Guhliche compares the color then obtained, which is very permanent, to the Turkey red. If the galls be left out, the color is clearer. A greater degree of brightness may be communicated to the first of these, by afterwards passing it through a bath of Brazil wood, to which one ounce of solution of tin has been added; the color thus obtained, he says, is very beautiful and durable.' The madder red of cotton is distinguished into two kinds; one is called simple madder red; the other, which is much brighter, is called Turkey or Adrianople red, because it comes from the Levant, and has seldom been equalled in brightness and durability by our artists. Galls or sumach dispose thread and cotton to receive the madder color; and the proper preparation is acetate of alumine. The nitrate and muriate of iron, as preparatives, produce a better effect than the sulphate (green vitriol) and acetate of the same metal; they both produce a beautiful and well-saturated violet color.

SPECIFIC GRAVITY

Is the relative, comparative, or apparent gravity in any body, in respect to that of an equal bulk or magnitude of another body; denoting that gravity, or weight, which is peculiar to each species or kind of body. In this sense, a body is said to be specifically heavier than another, when under the same bulk it contains a greater weight than the other; and reciprocally, the latter is said to be specifically lighter than the former. Thus, if there are two equal spheres, each one foot in diameter; the one of lead, and the other of wood; since the leaden one is heavier than the wooden one, it is said to be specifically heavier; and the wooden one specifically lighter.

This kind of gravity is by some called relative; in opposition to absolute gravity, which increases in proportion to the quantity, or mass, of the body.

For gases, common air is the standard; thus air is said to be 1.000, and any deviation of gravity in other gases is noted accordingly: thus hydrogen gas is 0.0732. Water is the standard for liquids and solids; it is also stated to be 1.000, but on a different scale. Sulphuric acid, in comparison with it, varies in gravity from 1.700 to 1.900.

A body specifically heavier than a fluid, loses as much of its weight when immersed in it as is equal to the weight or a quantity of the fluid of the same bulk or magnitude. Hence, since the specific gravities are as the absolute gravities under the same bulk; the specific gravity of the fluid will be to that of the body immersed, as the part of the weight lost by the solid is to the whole weight. And hence the specific gravities of fluids are as the weights lost by the same solid immersed in them.

As bodies specifically heavier than water, when immersed therein, lose of their absolute weight taken in the air, what an equal quantity of water in air would actually weigh; consequently, *the difference of the weight of any such body, taken first in air, and afterwards in water, will always be the just weight of a quantity of water, equal in bulk and dimensions to those of the body under consideration; and will be at all times fairly comparable with it.*

This famous proposition was first discovered by Archimedes, on the following occasion. Hiero, King of Sicily, ordered his goldsmith a certain

quantity of gold to make the crown royal. It was indeed well designed and finely embellished; but the artist, it seems, had made free with some of his Majesty's gold, and had substituted in its room an equal quantity of silver, or copper. On delivery of the work, a suspicion of mal-practice arose; the crown was surveyed, and the case was referred to Archimedes, with instructions not to deface the workmanship. It lay long before this mathematician, and the maker thought himself pretty secure of his payment. One day, however, as the philosopher stepped into a bath, he observed that the water rose in proportion to the part of his body immersed. From this fact he received a hint, wherewith he was so transported, that he jumped out of the bath, and ran, naked, about the streets of Syracuse, crying in a wild manner, "*I have found it! I have found it!*" In consequence of this speculation, he made two masses of the same weight as the crown; one of gold, the other of silver. These he severally let down carefully into a vessel of water, wherein the rise of the fluid might easily be determined by measure. Being of different specific gravities, they were consequently of different magnitudes, and, on immersion, took up the room of different quantities of water; by comparing these effects with their absolute gravities in the air, he became fully master of the relation in point of weight, which each of these metals had to water, and consequently to each other. He then examined the crown in the same manner; and by comparing his observations he at length detected the cheat, and accurately ascertained the quantities of gold and silver which it contained.

Rules.—To determine the Specific Gravity of Solids.—Fill a phial with water, and mark the weight of the whole accurately, in *grains*. Weigh 100 grains of the substance to be examined, and drop it gradually into the water in the phial. The difference in weight of the bottle and its contents now, and when filled only with water, will determine the specific gravity of the substance under examination. For example, if the bottle weighs 40 grains more than it did when it was filled with water only, it shows that 100 grains of the mineral displace only 60 grains of water; and, consequently, that it is of nearly twice the specific gravity of water.

To find the Specific Gravity of a Fluid.—On one arm of a balance suspend a globe of lead by a fine thread; and to the other fasten an equal weight, which may just balance it in the open air. Immerse the globe in the fluid, and observe what weight balances it then, and consequently what weight is lost, which is proportional to the specific gravity as above. Thus, the proportion of the specific gravity of one fluid to another is determined by immersing the globe successively in all the fluids, and observing the weights lost in each, which will be the proportions of the specific gravities of the fluids sought.

To find the Specific Gravity of a Solid lighter than the Fluid in which it is immersed.—Annex to the lighter body another that is much heavier than the fluid, so that the compound mass may sink in the fluid. Weigh the heavier body and the compound mass separately, both in water and out of it; then find how much each loses in water, by subtracting its weight in water from its weight in air; and subtract the less of these remainders from the greater.

Then, as this last remainder
Is to the weight of the light body in air,
So is the specific gravity of the fluid
To the specific gravity of that body.

The following table exhibits the specific gravity of a great number of different substances:—

SOLIDS.

Platinum	21,470	Brick	2,000
Gold	19,300	Earth	1,984
Iridium	18,680	Nitre	1,909
Tungsten	17,400	Vitriol	1,880
Mercury	13,600	Alabaster	1,874
Palladium	11,800	Horn	1,840
Woodanum	11,470	Ivory	1,820
Lead	11,350	Brimstone	1,800
Rhodium	10,650	Chalk	1,793
Silver*	10,450	Borax	1,717
Bismuth	9,880	Alum	1,714
Uranium	9,000	Clay	1,712
Copper	8,900	Dry-bone	1,660
Cobalt	8,600	Sand	1,520
Molybdenum	8,600	Gum-arabic	1,400
Nickel	8,400	Opium	1,350
Arsenic	8,350	Lignum-vitæ	1,327
Manganese	8,000	Coal	1,250
Iron	7,700	Jet	1,238
Tin	7,300	Ebony	1,177
Zinc	6,900	Pitch	1,150
Antimony	6,700	Rosin	1,100
Tellurium	6,120	Mahogany	1,063
Chromium	5,900	Amber	1,040
Columbium	5,600	Brazil wood	1,031
Selenium	4,300	Box wood	1,030
Ruby, Oriental	4,200	Bees' wax	95[illegible]
Garnet, Bohemian	4,186	Butter	940
Barium	4,000	Logwood	913
Strontium	3,800	Ice	908
Diamond	3,517	Ash (dry)	83[illegible]
White-lead	3,160	Plum-tree (dry)	826
Marble	2,707	Elm (dry)	801
Coral	2,700	Oak (dry)	800
Jasper	2,666	Yew	760
Rock crystal	2,650	Crab-tree	700
Pearl	2,630	Beech (dry)	700
Glass	2,600	Walnut tree	650
Flint	2,570	Cedar	613
Onyx stone	2,510	Fir	580
Glauber salt	2,250	Cork	238
Oyster shells	2,902	New-fallen snow	56

FLUIDS.

Quicksilver	14,000	Ale	1,028
Oil of vitriol	1,700	Vinegar	1,026
Oil of tartar	1,550	Tar	1,015
Honey	1,450	WATER	1.
Hydrochloric acid	1,315	Distilled waters	993
Nitric acid	1,300	Red wine	990
Treacle	1,290	Linseed oil	933
Aqua regia	1,234	Brandy	927
Human blood	1,154	Oil of olive	913
Urine	1,032	Spirit of turpentine	874
Cow's milk	1,031	Spirit of wine	866
Sea water	1,030	Oil of turpentine	810
Serum of human blood	1,030		

GASES.

Atmospheric air (being)	1.0000
Vapour of hydriodic ether	[illegible].4749
——— oil of turpentine	5.0120
Hydriodic acid gas	4.4130
Fluo-silicic acid gas	3.5735
Vapour of sulphuret of carbon	2.6447
——— sulphuric ether	2.5860
Chlorine	2.4700
Fluo-boric gas	2.3709
Vapour of muriatic ether	2.2190
Sulphurous acid gas	2.1920
Cyanogen	1.8064
Vapour of absolute charcoal	1.6133
Nitrous oxide	1.5204
Carbonic acid	1.5196
Muriatic acid gas	1.2474
Sulphuretted hydrogen	1.1912
Oxygen gas	1.1036
Nitrous gas	1.0288
Olefiant gas	0.9784
Azote, or nitrogen gas	0.9691
Oxide of carbon	0.9569
Hydro-cyanic vapour	0.9476
Phosphuretted hydrogen	0.8700
Steam of water	0.6235
Ammoniacal gas	0.5967
Carburetted hydrogen	0.5550
Arseniated hydrogen	0.5290
Hydrogen gas	0.0732

The specific gravities of the bodies contained in the foregoing table, and in all tables of this kind, can only be considered as the mean of a number of experiments made on each, and therefore cannot be considered as perfectly agreeing with the result of a single experiment, made for the purpose of determining the specific gravity of any particular substance; because the purity, the temperature, and several other causes, materially affect the result of an experiment of this kind. These numbers being the weight of a cubic foot, or 1728 cubic inches, of each of the bodies, in avoirdupois ounces; by proportion, the quality in any other weight, or the weight of any other quantity may be readily known.

For example:—Required the contents of an irregular block of millstone, which weighs 1 cwt., or 112 lbs., or 1792 ounces. Here, as 3500 : 1792 : 1728 : 1228¾ cubic inches the content.

Ex. 2.—To find the weight of a block of granite, whose length is 63 feet, and breadth and thickness, each 12 feet; being the dimensions of one of the stones of granite in the walls of Balbec. Here 63 × 12 × 12 = 9072 feet is the content of the stone; therefore as 1 : 9072 : :3500 to 31752000 oz. or 885 tons, 18 cwt. the weight of the stone.

To ascertain the purity of tin, &c., pewterers, and other dealers in tin, cast a bullet of pure tin, and another of the mixture of tin and lead, which they want to examine, in the same mould; and the more the bullet of the mixture exceeds the bullet of pure tin, in weight, the more lead they conclude it contains.

MAKING SHAGREEN

This manufacture is one of those in which the north and west of Europe are deficient; shagreen being indeed but little used, an imitation of it in paper sufficing for the generality of the uses to which it was formerly applied.

Real shagreen is a species of leather, manufactured from the skins of horses, mules, or asses; and particularly from the croup. The Orientals expose these skins for some days to the air and sun; after which they tan them, and render them as thin as possible. Mustard seed is then said to be placed upon the skin in regular order, the skin put into a press and dried. The impression of the seed remains on the skin, and, when properly prepared, the shagreen is beautiful; but if by any accident the impression is defective, the skin loses much of its value. Shagreen grows so very hard, as it dries, that the shagreen-case-makers are obliged to soak it in water to render it fit for their use. The appearance of shagreen may be easily imitated in morocco leather; but this imitation is easily distinguished from the real shagreen. Shagreeney morocco leather is torn with ease; real shagreen is so tough, that it cannot be torn by any ordinary force.

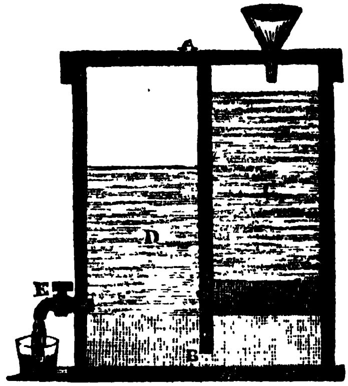
Real shagreen may be had of any color, but the grey shagreen, manufactured at Constantinople, is the most highly esteemed, both for its beauty and strength. It also is to be found of a black, green, or white color, and red, which last is the dearest, on account of the cochineal used in dyeing it. The Turks of Constantinople have the reputation of being the best manufacturers of shagreen: then those of Tunis, Algiers, and Tripoli. That manufactured in Poland is very harsh, and never well colored.

Sham shagreen is made by the Western Europeans from sheep and goat-skins, which are first tanned, and then shagreened, by being passed through a rolling press, the rollers of which are engraved, and heated as much as may be, yet so as not to render the skin horny. The appearance of shagreen is perfect, but the toughness of the real is wanted, and this imitation is easily torn.

Lately M. Merimée, in France, has attempted to improve the toughness of the sham shagreen, by the use of the acid of wood, but with what success is not yet known.

To the Editor.

Sir.—The following is a description of a Filtering Machine which I have constructed, and have had in use a considerable time, and strongly recommend it to all who wish to obtain pure water, it being extremely simple and economical in its construction, at the same time purifying the water equal to any of the *patent filters* now offered for sale to the public, and which many are prevented from using on account of their expense.



A represents a square or cylindrical vessel made of any suitable material; the one I have constructed is of zinc, which is cheap and durable. B a partition fixed so as to divide the vessel A into two chambers C and D; the bottom of this partition must be bored full of holes, or made about one inch shorter than the vessel A, so as to allow a free passage for the water between the two chambers. E is a cock to draw off the filtered water in the reservoir D. Procure some sea or river sand, and after having *well washed it*, fill both the chambers C D with the same, to the height of five or six inches. After having done this, fill the chamber C with *good* charcoal powder, to the depth of two or three inches—the machine is then ready for use. Pour the water to be filtered into the chamber C, and it will descend gradually through the charcoal and sand, and ascend through the sand in the chamber D beautifully clear and pure.

Particular care must be taken to *thoroughly cleanse the sand*, and have *good well-burnt charcoal*, which ought occasionally to be renewed. A lid should be fitted to the top to keep out dust, &c. And it is an improvement to pass the water through a strainer, or sponge, placed over the chamber C; this will prevent the charcoal from becoming foul, so soon, from the grosser impurities. My apparatus, which is only 12 inches diameter and 18 deep, will filter about 1 gallon per hour, but rapidity of filtering and purity of the water depend much upon the depth of the strata of sand and charcoal. G. S.

GOLD-LEAF

Usually signifies fine gold beaten into plates of exceeding thinness, which are well known in the arts of gilding, &c. The preparation of gold-leaf, according to Dr. Lewis, is as follows:—"The gold is melted in a black-lead crucible, with some borax, in a wind-furnace, called by the workmen a *wind-hole;* as soon as it appears in perfect fusion, it is poured out into an iron ingot mould, 6 or 8 inches long, and ¾ of an inch wide, previously greased and heated, so as to make the tallow run and smoke, but not take flame. The bar of gold is made red-hot, to burn off the unctuous matter, and forged on an anvil into a long plate, which is further extended by being passed repeatedly between polished steel rollers, till it becomes a ribbon as thin as paper. Formerly the whole of this extension was procured by means of the hammer, and some of the French workmen are said still to follow the same practice: but the use of the flatting-mill both abridges the operation, and renders the plate of more uniform thickness. The ribbon is divided by compasses, and cut with scissors into equal pieces, which consequently are of equal weights: these are forged on an anvil till they are an inch square, and afterwards well nealed, to correct the rigidity which the metal has contracted in the hammering and flatting. Two ounces of gold, or 960 grains, the quantity which the workmen usually melt at a time, make 150 of these squares, whence each of them weigh six grains and two-fifths; and as 902 grains of gold make a cubic inch, the thickness of the square plates is about the 776th part of an inch.

"In order to the further extension of these pieces into fine leaves, it is necessary to interpose some smooth body between them and the hammer, for softening its blow, and defending them from the rudeness of its intermediate action, as also to place between every two of the pieces some proper intermedium, which, while it prevents their uniting together, or injuring one another, may suffer them freely to extend. Both these ends are answered by certain animal membranes.

"The gold-beaters use three kinds of membranes—for the outside cover, common parchment; for interlaying with the gold, first the smoothest and closest vellum, made of calf-skin; and afterwards the much finer skins of ox-gut, stripped off from the large straight gut slit upon, curiously prepared for this use, and hence called *gold-beaters' skin.* The preparation of these last is a distinct business, practised by only two or three persons in the kingdom, some of the particulars of which have been already adverted to. The general process consists in applying one upon another, by the smooth sides, in a moist state, in which they readily cohere and unite inseparably; stretching them on a frame, and carefully scraping off the fat and rough matter, so as to leave only the fine exterior membrane of the gut; beating them between double leaves of paper, to force out what unctuosity may remain in them; moistening them once or twice with an infusion of warm spices; and, lastly, drying and pressing them. It is said that some calcined gypsum, or plaster of Paris, is rubbed with a hare's foot both on the vellum and on the ox-gut skins, which fills up such minute holes as may happen in them, and prevents the gold-leaf from sticking, as it would do to the simple animal membrane. It is observable, that notwithstanding the vast extent to which the gold is beaten between these skins, and the great tenuity of the skins themselves, yet they sustain continual repetitions of the process for several months, without extending or growing thinner. Our workmen find, that after 70 or 80 repetitions, the skins, though they contract no flaw, will no longer permit the gold to extend between them, but that they may again be rendered fit for use by impregnating them with the virtue which they have lost, and that even holes in them may be repaired by the dexterous application of fresh pieces of skin; a microscopical examination of some skins that had been long used plainly showed these repairs. Another method of restoring their virtue is by interlaying them with leaves of paper moistened with white-wine vinegar, beating them for a whole day, and afterwards rubbing them over as at first with plaster of Paris. The gold is said to extend between them more easily after they have been used a little than when they are new.

"The beating of the gold is performed on a smooth block of black marble, weighing from 200 to 600 pounds, the heavier the better; about nine inches square on the upper surface, and sometimes less, fitted into the middle of a wooden frame, about two feet square, so as that the surface of the marble and the frame may form one continuous plane. Three of the sides are furnished with a high ledge; and the front, which is open, has a leather strap fastened to it, which the gold-beater takes before him as an apron, for preserving the fragments of gold that fall off. Three hammers are employed, all of them with two round and somewhat convex faces, though commonly the workman uses only one of the faces; the first, called the *catch hammer,* is about four inches in diameter, and weighs 15 or 16 pounds, and sometimes 20, though few workmen can manage those of this last size; the second, called the *shodering hammer,* weighs about 12 pounds, and is about the same diameter; the third, called the *gold hammer,* or *finishing hammer,* weighs 10 or 11 pounds, and is nearly of the same breadth. The French use four hammers, differing both in size and shape from those of our workmen; they have only one face, being in figure truncated cones. The first has very little convexity, is near five inches in diameter, and weighs 14 or 15 pounds; the second is more convex than the first, about an inch narrower, and scarcely half its weight; the third, still more convex, is only about two inches wide, and four or five pounds in weight; the fourth or finishing hammer is nearly as heavy as the first, but narrower by an inch, and the most convex of all. As these hammers differ so remarkably from ours, it is thought proper to notice them, leaving the workmen to judge what advantage one set may have above the other.

"A hundred and fifty of the pieces of the gold are interlaid with leaves of vellum three or four inches square, one vellum leaf being placed between every two of the pieces, and about 20 more of the vellum leaves on the outsides; over these is drawn a parchment case, open at both ends, and over this another in a contrary direction, so that the assemblage of gold and vellum leaves is kept tight and close on all sides. The whole is beaten with the heaviest hammer, and every now and then turned upside down, till the gold is stretched to the extent of the vellum; the case being from time to time opened for discovering how the extension goes on, and the packet, at times, bent and rolled, as it were, between the hands, for procuring sufficient freedom to the gold, or, as the workmen say, to

make the gold work. The pieces taken out from between the vellum leaves are cut in four with a steel knife; and the 600 divisions hence resulting are interlaid in the same manner, with pieces of the ox-gut skins five inches square. The beating being repeated with a lighter hammer, till the golden plates have again acquired the extent of the skins, they are a second time divided into four; the instrument used for this division is a piece of cane cut to an edge, the leaves being now so light, that the moisture of the air or breath condenses on a metallic knife. These last divisions being so numerous, that the skins necessary for interposing between them would make the packet too thick to be beaten at once, they are parted into three parcels, which are beaten separately with the smallest hammer, till they are stretched for the third time to the size of the skins; they are now found to be reduced to the greatest thinness they will admit of, and indeed many of them before this period break or fail. The French workmen, according to the minute detail of this process given in the *Encyclopedie*, repeat the division and the beating once more; but as the squares of gold, taken for the first operation, have four times the area of those used among us, the number of leaves from an equal area is the same in both methods, viz. 16 from a square inch. In the beating, however simple the process appears to be, a good deal of address is requisite for applying the hammers so as to extend the metal uniformly from the middle to the sides; one improper blow is apt not only to break the gold leaves, but to cut the skins.

"After the last beating, the leaves are taken up by the end of a cane instrument, and being blown flat on a leather cushion are cut to a size, one by one, with a square frame of cane made of a proper sharpness, or with a frame of wood edged with cane; they are then fitted into books of 25 leaves each, the paper of which is well smoothed and rubbed with red-bole to prevent their sticking to it. The French, for sizing the leaves, use only the cane-knife, cutting them first straight on one side, fitting them into the book by the straight side, and then paring off the superfluous parts of the gold about the edges of the book. The size of the French gold leaves is somewhat less than three inches square; that of ours from three inches to three inches and three-eighths.

"The process of gold-beating is considerably influenced by the weather. In wet weather, the skins grow somewhat damp, and in this state make the extension of the gold more tedious: the French are said to dry and press them at every time using; with care not to over-dry them, which would render them unfit for further service. Our workmen complain more of frost, which appears to affect the metalline leaves themselves; in frost, a gold-leaf cannot easily be blown flat, but breaks, wrinkles, or runs together.

"Gold-leaf ought to be prepared from the finest gold; as the admixture of other metals, though in too small a proportion to sensibly affect the color of the leaf, would dispose it to the loss of its beauty in the air. And indeed there is little temptation to the workman to use any other; the greater hardness of alloyed gold occasioning as much to be lost in point of time and labour, and in the greater number of leaves that break, as can be gained by any quantity of alloy that would not be at once discoverable by the eye. All metals render gold harder and more difficult of extension: even silver, which in this respect seems to alter its quality less than any other metal, produces with gold a mixture sensibly harder than either of them separately, and this hardness is in no art more felt than in the gold-beater's.

"The French are said to prepare what is called the *green gold-leaf*, from a composition of one part of copper and two of silver with eighty of gold, but this is probably a mistake; for such an admixture gives no greenness to gold: and I have been informed by our workmen, that this kind of leaf is made from the same fine gold as the highest gold-colored sort, the greenish hue being only a superficial tint induced upon the gold in some part of the process: this greenish leaf is little otherwise used than for the gilding of certain books.

"But though the gold-beater cannot advantageously diminish the quantity of gold in the leaf by the admixture of any other substance with the gold, yet means have been contrived, for some particular purposes, of saving the precious metal, by producing a kind of leaf called *party gold*, whose basis is silver, and which has only a superficial coat of gold on one side; a thinner one of gold, laid flat on one another, is heated and pressed together, and coheres; and being then beaten into fine leaves, as in the foregoing process, the gold, though its quantity is about one-fourth of that of the silver, continues every where to cover it, the extension of the former keeping pace with that of the latter."

JAPANNING TUNBRIDGE-WARE.

BY A TUNBRIDGE-WARE MANUFACTURER.

SUCCESS in varnishing Tunbridge-ware boxes, &c., depends very much on the varnish employed—viz. white hard spirit, or Tunbridge-ware varnish; as if this is not of the peculiarly suitable kind, whatever pains you take, you will be unsuccessful: the white hard varnish of the shops, though good for other purposes, will not answer for this: you may procure the right kind at Smith's, 121, Fore-street, Cripplegate. It must always be used in a room heated a few degrees above summer heat. If the room is too cold, the varnish, when laid on, will turn white —or, as it is technically termed, chill; and if too hot, it will rise in small bladders or blisters. Both these must be avoided. Use it in a pot with a wire fastened across the top, against which the tool (a flat camel-hair varnish tool,) must be worked continually, to regulate the quantity in the tool at once; the surplus running from the tool and wire again into the pot—it is not so good for keeping, and must be kept from the air as much as possible: the highest rectified spirits of wine is the only thing that will improve it if too thick, and soften the tool if it gets too hard. This varnish I shall, in my future description, call spirit varnish; and I have been thus particular, as success depends on the proper quality and management of it.

Of course, in speaking of the painting and ornamenting, I can only describe the *material*, and give general directions—taking for granted, it will be of no use any person attempting it without some previous knowledge of drawing or painting. The colors used are the same as for oil-painting, but in a dry state; they are to be ground fine in turpentine and let dry; they are then fit for use; some of the smooth colors, as vermillion, lamp-black, &c., do not require grinding in turpentine first. The colors, when used, are to be mixed on a palette, or marble slab, rather stiff with copal varnish, and thinned for use with turpentine; they require copal

varnish enough to make them bind, and dry firm, and work free, but not enough to make them shining or sticky. With these colors you may paint groups of flowers, shells, arabesque borders, or imitations of wood, &c.; when gilding is wished, use japan gold size—always bearing in mind that any ground color, imitation-wood, &c., upon which gold ornaments are to appear, must have one coat of spirit-varnish over it before sizing; which is always necessary also when flowers, &c. are painted on a black or other colored ground—the spirit-varnish preventing the ground color from working up. Colored prints or drawings on paper, pasted close and tight on the wood, form a pretty centre; they must always be sized with isinglass size, twice over, before they are varnished over with the spirit-varnish. Have a little cup of turpentine by you when painting, to moisten the pencils (camel-hair) and make them work free—wash them in turpentine, and keep your colors from the air as much as possible.

The articles are usually made either of horse-chesnut or sycamore wood, the whiter the better, and should be well finished off with glass paper; wipe them, and give them one coat of spirit-varnish—this raises the grain; rub down with fine glass paper when dry; wipe from the dust, and varnish again with spirit-varnish, and they are properly prepared for painting; but prints or drawings must be put on previous to this preparation. In preparing articles for ladies to paint on, as they use water-colors instead of copal ones, omit the two coats of spirit-varnish, using instead a white varnish, made of finely-powdered flake white and isinglass size, used hot, rubbed down in the same way, and repeated.

(*Continued on page* 150.)

USES OF KAURI RESIN IN THE ARTS.

THE kauri wood of New Zealand was first noticed by Capt. Cook, as a very fine mast-timber; but it is only lately that some cargoes of it have been received in this country (at Plymouth dock-yard), which fully bear out the high reputation which this wood had previously attained. Mr. Yate describes the tree under the name of *Dammara australis*, or *Pinus Kauri*, as running from 85 to 95 feet high without a branch, and sometimes 12 feet diameter, yielding a log of heart timber, 11 feet diameter. One he measured, perfectly sound, 40 feet 11 inches circumference. The wood has much the appearance of deal, and yields a strong odour of the resin. The tree is crowned with splendid foliage; its leaves resembling those of the English box. From the trunk oozes a white, opaque substance; also a kind of resin, answering the purposes of resin in ship-building, both having a strong resinous smell —the former very fragrant, and chewed on that account by the New Zealanders. Both diffuse themselves over the whole tree, the cone and leaf being equally tinctured with them, whilst they may be seen exuding from the tips of the leaves on the highest branches. Mr. Prideaux, of Plymouth, who has communicated to the *Philosophical Magazine* a paper on this resin, concludes the first of the above substances to be the more recent exudation, and to be more or less compressible from the presence of its essential oil; whilst he considers the resin to be that which has lost, by time or exposure, the essential oil and a little moisture, and thus become hard and transparent. In looking over several hundred-weights, Mr. Prideaux found the resin in every stage of the difference.

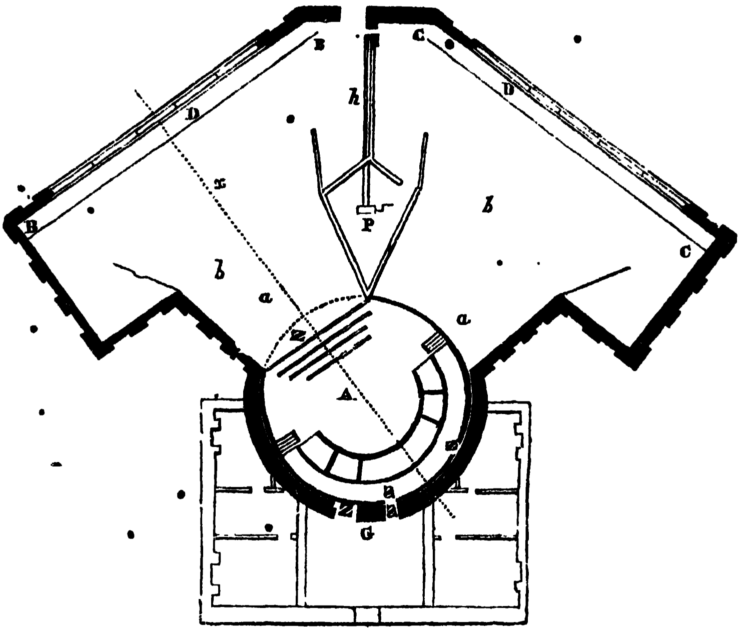
Mr. Prideaux next details a series of very interesting experiments with the kauri resin, and deduces therefrom its several uses in the arts. From its hardness, fragrance, and brilliance, the white parts seem well suited for varnish-making, for which its solubility in alcohol gives it great advantage. Harder and more free from color than mastic, quite as soluble, and at, perhaps, less than one-tenth the price, it seems to be an important addition to our materials for alcoholic varnishes. It may, indeed, come to be placed at their head, though its insolubility in pyroacetic acid is an unfortunate limit to its utility. Its hardness, fragrance, and inflammability, pointed it out as suitable for sealing-wax; but combined with lac and turpentine it answers better, and the manufacturer will soon ascertain the fittest proportions. Mr. Prideaux best succeeded with kauri and lac, each one ounce, resin three-quarters of an ounce, oil of turpentine half an ounce, vermillion one ounce; powder together the lac, kauri, and resin; add the vermillion, and then the turpentine. Let them remain a few days in a well covered vessel, then melt them together in a very gentle heat. The kauri will liquify in this composition; it burns well, drops freely, and takes a fine impression, bu it does not always adhere firmly to the paper. Another purpose for which its brilliant inflammability and comparative infusibility qualify it, if it come in largely and cheaply, is gas-light. A modification of the oil-gas apparatus would work it, and the material being supposed at one-fourth the price of oil, while the original outlay in pipes, &c., would be in the same proportion as for oil-gas, it would stand a fair chance in competition with coal-gas, and be much less disagreeable in houses than any gas hitherto employed. As to its officinal employment in medicine and surgery, time and experience only can indicate them. External application seems most suited for it; for its masticatory employment is not very likely to be adopted in Europe.

MISCELLANIES.

Answer to Query 167.—*Preparation of Turkeys' Crops for Balloons.*—Free the crop from its thick coat of fat; turn the inside out, and wash the food out; soak it in water for a day or two, then lay it on a cloth and with a bone or knife scrape off the internal coat of the stomach, wash it well, and dry it with a clean cloth; then turn the crop, and make an incision through the external coats, taking particular care not to cut through the membrane; draw the coats at once over the neck, which must be cut long for greater convenience in using the balloon when finished. Proceed with the other neck in the same way; tie it firm with silk, and cut it close to the body of the balloon; it must be then distended with wind and hung up to dry. They may then be painted and varnished, but will not require it if properly prepared. They may be made large enough to contain a gallon of gas, and so light as to weigh only 30 grains.

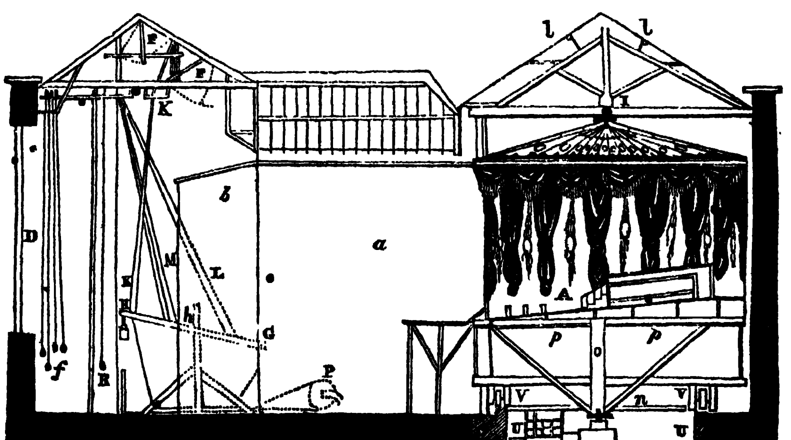
Incombustible Clothing.—If cotton and woollen articles of dress, after washing, be rinsed in a solution of nitre, it will prevent their readily taking fire, and, at the same time, will improve their appearance.

Fig. 1.



THE DIORAMA.

Fig. 2.



THE DIORAMA.

AMONG all the contrivances to gratify the public curiosity the above exhibition stands certainly pre-eminent. The imposing magnificence of the subjects, the splendour of the paintings, the vivid illusion of the scene—all conspire to render it an object of supreme interest and delight to this sight-seeking nation; and the popularity which it has attained, founded on the sure and permanent basis of real excellence is a certain indication of its intrinsic value as a work of art.

The invention consists in placing the pictures or painted scenery within a building so constructed, that the saloon or amphitheatre containing the spectators may be caused to revolve at intervals, as may be desired, for the purpose of bringing in succession two or more distinct scenes or pictures into the field of view, and without the necessity of the spectators removing from their seats. From this arrangement of the revolving saloon, the scenery or pictures themselves may remain stationary, and will therefore admit of the application of an improved method of distributing or directing the daylight upon or through them, so as to produce the effects of varying the light and shade in a more pleasing manner than has otherwise been accomplished. The effects are produced by means of a number of colored transparent and moveable blinds or curtains, some of which are placed *behind the picture*, for the purpose of intercepting and changing the color and shades of the rays of light—which being permitted to shine or pass through certain semi-transparent parts of the picture, produce many curious changes in the appearance of the color, in proportion as the colored blinds are moved up and down. This motion is performed in a peculiar order by the aid of cords connected with the machinery, which we shall presently describe. Other colored transparent blinds are situated above and in front of the picture, which are also moved by lines, and by that means distribute or direct the rays of light which are permitted to fall upon the *face of the picture*, and thereby effect many surprising changes in the appearances of the colors of the painting.

Fig. 1, in the engraving, gives a horizontal plan of the building in the Regent's Park, in which are now being exhibited two magnificent pictures, each of them consisting of several thousand square feet of canvas. A shows the plan of the revolving saloon, conveniently fitted up with a circular range of boxes and seats at the back part, and with several rows of benches in front; the remaining space is a carpeted floor laid upon an inclined plane, for spectators who choose to stand. B B shews the situation of one of the pictures; and C C the situation of the other. D D are two large windows, fitted with ground or semi-transparent glass, to admit a portion of light behind the picture. The saloon is a building of a cylindrical form, and has a spacious opening, Z, in one side, for viewing the picture through. The doors for the admission and departure of the company are situated at S S and Z Z on the opposite side. The spaces between the opening of the saloon and the pictures is inclosed above and on each side by light screens, forming a kind of vista, (as seen at *a a* and *b b*) which, concealing the margin of the picture, produce in a certain degree the effect of panoramic pictures.

Fig. 2 represents a vertical position of the building and apparatus, in the direction of the dotted line *x* drawn on the plan, and the letters of reference are the same in both of the figures for the corresponding parts. Consequently A shows the saloon, the walls of which are elegantly decorated with drapery and painted devices; and the ceiling, which is of a slightly conical figure, is tastefully ornamented with a transparent painting, which designedly admits of but a very sombre light from skylights placed above. B is one of the pictures suspended from above, and kept in a proper degree of tension by small weights hung on at both ends, and also at the sides, at which place the lines for the weights pass over small pulleys fixed to a stationary rail not shown in the engraving. Before the window D the colored transparent blinds are suspended by lines, so as to be capable of moving up and down, in order to pass by and overlay each other; five of these are represented at *f*, but there may be a considerably greater number used, which will depend entirely upon the nature of the painting or scenery to be exhibited, and must, as well as the arrangement of their movements, and also the color of the cloth, be determined by the judgment of the painter. F shows a large sky-light in the roof of the picture room for the admission of light upon the face of the picture; this window is likewise fitted with ground glass, and furnished with transparent colored blinds, as seen at F F, which move upon hinge joints fixed to their uppermost ends, so as to be capable of moving into the dotted position, thereby permitting the rays of light to fall unobstructed upon the face of the picture; when they are raised up as shown in the figure, they intercept part of the light, and when brought fully up they may be made to close up the window entirely, and thereby cause all the rays of light to pass upon the picture through the colored shades, so as to produce variations in the shades and tints upon the picture.

The colored blinds are moved by cords or lines, which proceeding from them, pass over small pulleys near the top of the building, and then descending are attached to a long lever or balance, G H, which moves upon a centre or fulcrum at *h*. This part of the apparatus is situated in that intermediate portion of the building between the two picture rooms, as seen at *h* in the plan, Fig. 1. The lines K proceed over small pulleys, *k*, and over leading pulleys situated at the end of the roof of the building, after which they are attached to extremities of the blinds, F F, in order to close or open them. There are five pairs of these blinds in the length of the building, but only one pair exhibited in the figure. The cords marked L, and those marked M, proceed over small pulleys in the roof of the building, and are then attached to the hanging blinds, *j*. The lower ends of these cords, L and M, are attached to the lever G H on opposite sides of the fulcrum, consequently, when the lever is moved on its centre, some of the blinds will ascend and others descend, so as to pass over each other, and produce different tints of light: but no precise or even general rules can be laid down for these motions, as they must depend entirely upon the nature of the scene and the intention of the artist. When it is desired to produce the change in the lights and shades of the picture, a workman draws the end H of the lever slowly downwards, by turning the winch P shown in Fig. 1, and also by dotted lines at P in Fig. 2, where two ends of a rope proceed over pulleys, and are attached to opposite ends of the lever G H; this rope winds round a barrel, which is turned by a pinion and cog wheel from the winch P, and the ends of it pass off on opposite

sides of the barrel, so that a variety of changes is produced by turning the winch round in contrary directions. A balance weight is attached to one end of the lever G H, for the purpose of balancing the weight of the blinds. The extent of motion which the various colored blinds may require to have communicated to them, can be obtained by attaching their lines or cords to the lever G H, nearer to or further from the centre of motion.

The floor of the revolving saloon is supported upon a very strong timber frame-work, which consists of a central shaft or axis, *a*, having twelve timbers or arms similar to those at *p p*, arranged round it at equal distances in the manner of radii; the extremities of these timbers are connected by upright pieces; and the whole framing further strengthened by diagonal braces and cross-timbers, which, proceeding from one arm to the next, are firmly bolted to each, and form a pentagonal framing. The cross-timbers serve to carry the bearings of twelve strong iron shafts, which form the axis to twelve cast-iron wheels or rollers, two of which are shown at *v v*. These wheels roll round upon the surface of a circular metal curb or ring, firmly bolted to a course of masonry situated upon the top edge of the circular wall U U. This wall having to support the revolving amphitheatre above, has a very solid foundation many feet below the surface. The central shaft *o* is furnished with a pivot or gudgeon at its lower extremity, which works in a brass step-piece, is fitted with adjusting screws, and securely fixed on a pier of masoury. The cylindrical part of the saloon above the floor is composed of light wood framing, internally decorated as before mentioned. The roof of the saloon is furnished with a gudgeon or pivot in the centre, adapted to turn round in a beam affixed to one of the principals of the main roof as seen at I. *l l* shows a sky-light for admitting light through the transparent ceiling of the saloon.

The extent of the circle described by the revolving motion of the saloon, in exhibiting the two pictures alternately, forms an arc of about 73°; and during the time that the saloon is in motion no company is permitted to go in or out; but when the opening S is brought in the proper situation opposite to either of the pictures, one of the two doors, *s z*, of the saloon will be found to correspond exactly with one of the door-ways respectively marked *s z* shown in the circular brick wall surrounding the saloon, and will thus open a direct entrance to it. On the outside of this circular wall a suitable room at R is provided for such of the company to wait in that arrive at the moment the saloon is in motion.

We have now only to describe the method by which the revolving motion of the saloon is effected, and we regret that the very limited space allowed for the delineation of this part of the machinery renders it not very clear in the Fig. 2. A portion or segment of a wheel with cogs, *n*, is firmly fixed to the central shaft *o*, so that its cogs may be engaged with the cogs of a pinion fixed upon a vertical shaft, which has a bevilled wheel at its lower extremity; this wheel is engaged with the teeth of another bevilled wheel placed in a vertical position; and as the axis of the last-mentioned bears also a cog wheel, they revolve together. This train of wheels is set in motion by a small pinion, which is immediately operated upon by the turning of a winch with a fly wheel upon the same axis to regulate the power.

ILLUSTRATIONS OF THE LINNÆAN SYSTEM. NAMING PLANTS, &c.

(Resumed from page 59.)

THE observations on pages 58 and 59 will readily suggest the method to be adopted in finding the name of an unknown plant. For example, suppose we gather one from the fields, and possess some book which we know contains a description of it. We may not be aware of the name of the plant we have gathered, and consequently know not in what part of the book such a description is to be found. To ascertain this, we must proceed as follows:—First, directing our attention to the flowers, we find that there are five distinct stamens; from which we conclude it to be of the class Pentandria. Next we observe the number of styles; there being but one, the order it belongs to is Monogynia. We must now turn to the proper class and order in the book we possess, and there we shall find a variety of genera arranged under each other, and very often collected into little groups. Reading over the characters of these genera, our plant will agree with only one of them—for instance, with Primula, or the Primrose family, whose characters are, calyx tubular and five-toothed; corolla salver-shaped; its tube cylindrical; its mouth open. Capsule opening with ten teeth.

As these characters belong to no other genus whatever, we cannot err thus far, and it only remains for us to discover what species of Primula we have plucked. For this purpose we have to turn a little further in the book, where Primula is more fully described, and which the index, or our own observation, will easily direct us to. Here five British species are described as follows:—

* LEAVES GREEN. FLOWERS YELLOW.

Common Primrose... Flowers single on the stalk.

Oxlip.. Flowers many on the stalk; corolla flat.

Cowslip.. Flowers many on the stalk; corolla concave.

* LEAVES MEALY. FLOWERS PINK.

Bird's-eye Primrose.. Leaves crenate; calyx oblong, ovate.

Scottish Primrose.. Leaves dentate; calyx swelled out.

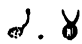
By attending to the above it is easy to know our plant, for as it agrees only with the first description, it must be the *Common Primrose*, that "meek and soft-eyed emblem of childhood," which greets us with the promise of coming spring, and which brightens the mossy hedge-rows with its smiling yellow flowers.

The above method of naming unknown plants is applicable in all other cases, both on wild and garden flowers: it implies but little labour, and occupies, except in difficult cases, but little time. Still to the young botanist it may appear difficult, but let him remember that every step in his progress renders what is to come more easy. When he knows one of the above species, he has but to look at four descriptions instead of five, whenever he has procured a second species—a third is still more easily found out, and so on in all instances.

The following observations on the various Linnæan classes, and examples of some plants found under each, will much assist the student's general knowledge of classification. He may gather any plant mentioned, and compare it with the characters of the class.

Class I.—Monandria. Two orders

Containing plants with only 1 stamen, and 1 or 2 styles.



A small class, containing among its hardy plants, the elegant Strawberry Blite, and the Red Centranthus, otherwise called Red Valerian. Its hothouse plants are many of them interesting and beautiful; among them are the Ginger, the Arrow Root, and the Turmeric. The Saltwort, the Water Starwort, and the Mare's-tail, are all that England calls her own; and these, which are mud plants, possess but little beauty or interest.

Class II.—Diandria. Three orders.

Containing plants with 2 stamens, and 1, 2, or 3 styles.

An interesting, though small class—many of its flowers are both beautiful and fragrant. The Jasmine, the Lilac, the Rosemary, and the Privet, are among them. Here, too, we find the Olive, the Pepper plant, the Sage, (of which there are no less than 170 species,) the Veronica family, the Schizanthus, and the curious little Bladderwort, so remarkable for its root. In the second order is almost the only Grass which bears a scent; it is called the Sweet-scented Vernal Grass, and in the spring covers most of our dry and road-side pastures. It is a favorite with the cattle, and, when dried, will retain its scent for years.

Class III.—Triandria. Three orders.

Containing plants with 3 stamens, and 1, 2, or 3 styles.

A class extensive, important, and varied. It contains, in the first order, the Crocus, the Iris, and most of the beautiful bulbous plants of South Africa. Following these are numerous rush-like plants of native growth, and the sacred Papyrus, the plant from whose pithy, rush-like stem, the ancients procured there first, and, for many ages, there only paper. In the second order is that numerous and valuable tribe, the Corn, the Grasses, the Reeds, and the Sugar Cane.

Class IV.—Tetrandria. Three orders.

Plants with 4 stamens of equal length, and 1, 2, or 4 styles.

We find but few plants, with four stamens, yet among them are some of interest. The Plantain of the fields is well known to us all. The Teasel, whose receptacle is so valuable in fulling cloth, and whose leaves are so formed as to retain the water upon them, belongs here; so also does the bright and glossy-leaved Holly. The Scabious, the Goose-grass, and that vegetable ingrate, the Dodder.

Class V.—Pentandria. Six orders.

Plants with 5 stamens, and 1, 2, 3, 4, 5, or many styles

Pentandria contains no less than about one-fifth of the whole flowering plants. It begins with the rough-leaved kinds. The Bugloss and the Comfrey are among them. Then there is the lovely little "Forget-me-not," that blossoms bright and blue on the rippling stream. The curious Pimpernel or Poor Man's Weather Glass, is its near attendant. Then follow the aspiring Bell-bine, the lowly Primrose, and the fragrant Violet, the Coffee, the Tobacco, the Capsicum, the Balsam, the luscious Grape, the noble Teak tree, (that lord of the Asiatic forest,) and the shining Currant. The poisonous family of the Nightshade, in which are the Egg plant, the Love Apple, and the Potatoe, bear them company in the first order. In the next comes that extensive tribe, the Umbellate plants, as the Carrot, the Parsley, the Parsnip, and the Hemlock. In the order Trigynia, among others, are the Guelder Rose, the Elder, and the Sumach. In the order Tetragynia is but the Grass of Parnassus, a lovely plant of our mountain pastures. In Pentagynia are the thick-leaved Crassulus, the useful Flax, the Thrift, and the curious Sundew.

The three English species of Sundew.

Class VI.—Hexandria. Four orders.

Plants with 6 equal stamens, and 1, 2, 3, or many styles

This class claims our notice from the beauty of some of its examples, no less than from the utility of the rest. Who has not observed and admired the elegant form, colors, and beauty of the Lilies, the Snowdrop, the Narcissus, the Tulip, the Hyacinth, and almost all the rest of the bulbs? These are not all, even in the first order, for we have the noble Banana or Plantain tree, the Aloe, the Pine Apple, the Bamboo and Rattan Cane, the Fan Palm, the Yucca, the Lily of the Valley, and the Asparagus. The Rice, that valuable plant which grows in water, where nothing else fit for human food will flourish, and which supplies with nutriment no less than one-third of the whole human race, belongs to the second order of this class. In the third are placed the large family of the Docks, one species of which is the common Sorrel.

(*Continued on page 132.*)

FROZEN WELL.

Near Owego, occurs this apparent contradiction of nature's laws, which is thus described by a correspondent in *Silliman's Journal.*

The well is excavated on a table of land, elevated about thirty feet above the bed of the Susquehanna River, and distant from it three-fourths of a mile. The depth of the well, from the surface to the bottom, is said to be 77 feet; but for four or five months in the year, the surface of the water is frozen so solid as to be entirely useless to the inhabitants. On the 23d of the present month, (Feb.) in company with a friend, I measured the depth, and found it to be 61 feet from the surface of the earth to the ice which covers the water in the well, and this ice we found it impossible to break with a heavy iron weight attached to a rope. The sides of the well are nearly covered with masses of ice, which, increasing in the descent, leave but about a foot space (in diameter) at the bottom. A thermometer let down to the bottom, sunk 38° in 15 minutes, being 68° in the sun, and 30° at the bottom of the well. The well has been dug 21 years, and I am informed by a very credible person who assisted in the excavation, that a man could not descend to work in it for more than two hours at a time, even with extra clothing, although in the month of June, and the weather excessively hot. The ice remains until very late in the season, and is often drawn up in the months of June and July. Samuel Mathews drew from the well a large piece of ice on the 25th day of July, 1837, and it is common to find it there on the 4th of July.

The well is situated in the highway, about one mile northwest of the village of Owego, in the town and country of Tioga. There is no other well on that table of land, nor within 60 or 80 rods, and none that presents the same phenomenon. In the excavation, no rock or slate was thrown up; the water is never affected by freshests; and is what is usually denominated "hard," or limestone water. A lighted candle being let down, the flame became agitated and thrown in one direction at the depth of 30 feet, but was quite still, and soon extinguished at the bottom. Feathers, down, or any light substance, when thrown in, sink with a rapid and accelerated motion.

Professor Silliman, in attempting to solve this extraordinary and difficult problem, observes: At the depth of more than 60 feet, water ought not to freeze at all, as it should have nearly the same temperature of that film of the earth's crust, which is at this place affected by atmospheric variations, and solar influence, being of course not far from the medium temperature of the climate. Could we suppose that compressed gases, or a greatly compressed atmosphere were escaping from the water, or near it, this would indicate a source of cold; but as there is no such indication in the water, we cannot avail ourselves of this explanation, unless we were to suppose that the escape of compressed gas takes place deep in the earth, in the vicinity of the well, and in proximity to the water that supplies it. Perhaps, this view is countenanced by the blowing of the candle at the depth of 30 feet, blowing it to one side, thus indicating a jet of gas which might rise from the water as low as its source; and even if it were carbonic acid, it might not extinguish the candle, while descending, as the gas would be much diluted by common air; and still, in the progress of time, an accumulation of carbonic acid gas might take place at the surface of the water, sufficient to extinguish a candle.

LITHOGRAPHY.

(*Resumed from page 95.*)

Lithographic Stones.—Any stone which effervesces with an acid, which imbibes water with facility, and is easily penetrated by greasy substances, is fit for lithography. It is well known that carbonate of lime fulfils these conditions; next to silex, lime is the earth found in greatest abundance on the surface of our globe, and chiefly in the state of carbonate. It is found, first, in masses in primitive beds, and almost always of a white color, and in a pure state; secondly, in transition beds, in masses of different colors, proceeding from the detritus of the first; such are marbles; thirdly, in beds of later formation; in these it is found in abundant strata; but it is necessary to choose amongst these, as these beds or deposits formed by water are almost always of a coarse texture, intermixed with crystals or filled with shells.

By this it is easy to see that lithographic stones are not scarce; from the coarse calcareous stone which serves for buildings, to the compact calcareous ones, which receive the polish of marble; an infinite variety of other stones exist, which contain with lime, silex and alumina, and the two latter even to excess, and which are all more or less proper for lithography.

Lithographic stones may consequently be found in chains of mountains, on hills, and in plains; those, therefore, who are in search of them, ought to be provided with a small bottle of nitric acid, and whenever a white stone is found which does not strike fire with steel, it must be tried with the acid, and if an effervescence takes place, it is a lithographic stone. The following are the rules by which the best may be selected:—

The best lithographic stone hitherto found breaks with a conchoidal fracture; it is of a fine homogeneous texture, its color is a uniform and yellowish white, being nearly similar in appearance to the hone stones used in sharpening razors; on breathing on them, a slight aluminous smell, (similar to that of pipe-clay,) is perceived.

The quarry from which the first lithographic stones were extracted, is still that which furnishes them in the greatest abundance, and of the largest dimensions. It is situated at Solenhofen, near Papenheim, in Bavaria. No quarries hitherto known in France give stones equal to the German ones.

Stones, however, have been found near Chateauroux, which in some respects have a great advantage over the Bavarian ones; they are much harder, of a finer texture, they preserve much better the soft tints in chalk engravings, and the impressions are much brighter. For these reasons, the French stones would be far superior to the German, were they not interspersed with innumerable spots and defects, so that it is extremely difficult to find one, 18 inches square, which is free from them.

We have tried some stones extracted from a new quarry, found near Chatellerault; they appear to possess all the necessary qualities: they may be procured of any size; they are white, slightly inclined to a grey, excessively hard, and highly aluminous; they absorb both water and grease with equal avidity. Lines drawn upon this stone print with great purity, and it is perhaps preferable to any other for ink drawings.

Next to these stones, which are the only ones to be employed for highly finished drawings, we may rank white marbles, which are not so proper for lithography. After these, come the common calcareous stones, which produce drawings of various qualities according to the more or less fineness of their texture; and last of all, the coarsest calcareous stones, which from the number of foreign substances they contain, cannot be employed in lithography.

Sawing and Polishing the Stones.—In order to withstand the necessary pressure, a stone a foot square must not be less than two inches in thickness; and one three feet square, must be at least four inches thick.

When stones are a great deal thicker than is necessary, they may be divided by a saw and sand, as is done with marble; and after they have been squared, they must be rubbed face to face with sand and water, and the edges rounded with a file and smoothed with pumice-stone, using the sand finer and finer by degrees, until the surface is perfectly smooth and even, when the stone will be ready for the draughtsman.

Different grains are given, according to the nature of the drawings: fine and delicate drawings require a very fine grain, while bold and spirited ones require a coarser one.

Rubbing off Chalk Drawings.—When a stone is done with, and it is wished to rub off the drawing which is on it, in order to execute another, it must be first rubbed with sand until the lines of the drawing have disappeared; it must then be washed with a mixture of aquafortis and water, (in the proportion of one part of acid to twenty of water.) This operation is indispensable in order to destroy the former drawing, which otherwise would reappear in the printing; it is then rubbed with fine sand, and treated in every respect as in the first preparation of the stone.

Preparation of Stones for Ink Drawings.—The stones having been prepared with fine sand, as is done for chalk drawing, must be well washed, and carried to a table perfectly free from sand or dust; they must then be rubbed face to face with powdered pumice-stone and water; when perfectly smoth, they must be again washed. This being done, take a large pumice-stone, of a fine texture, and rub each stone separately with it, and with a circular motion; this must be continued until the stone is polished, and perfectly free from grain or scratches.

When it is wished to give a still higher polish, the stones are often rubbed with a rag and pumice-stone well powdered and sifted; it must be afterwards washed and rubbed violently with a linen rag; the stone is then ready for the draughtsman.

Rubbing off Ink Drawings.—In order to rub off ink drawings, the surface of the stone must be strewed with powdered pumice-stone and water, another stone laid over it, and thus they must be rubbed face to face until the drawing disappears: acid and water are now to be poured on the stone, which must be afterwards washed and prepared afresh as in the first instance.

(Continued on page 129.)

ASSAM TEA.

It will be remembered that, upon the discovery of the tea-plant being indigenous in Upper Assam, Mr. C. A. Bruce was sent thither to explore the tea country, and was appointed superintendent of its culture. He then proceeded to raise plantations; and, in the year 1838, transmitted to England eight chests of "Assam Tea," each containing 320 lbs. It appears, also, that Mr. Bruce has drawn up his second Report, which has been presented by the Tea Committee appointed by the Bengal Government.

Notwithstanding the troubles in which the frontier of Assam has been involved, Mr. Bruce has altogether discovered 120 tea-tracts, some of them very extensive, both on the hills and in the plains; whence a sufficient number of seeds and seedlings might be collected, in the course of a few years, to plant off the whole of Assam.

In 1838, on going over one of the hills behind Jaipore, about 300 feet high, Mr. Bruce discovered a tea-tract between two and three miles in length; the trees were mostly as thick as they could grow, and the tea-seeds (smaller than he had seen before,) literally covered the ground: this was in the middle of November, when the trees had abundance of fruit and flower on them. One of the largest trees was two cubits in circumference, and fully forty cubits in height. At the foot of the hill was another tea-tract, and doubtless many of the Naga hills are covered with tea. Mr. Bruce crossed the Dacca river at the old fort of Ghergong, and, walking towards the hills, almost immediately came upon tea; and in two days journey he saw thirteen tracts. Farther south-west, the small hills adjoining Gabrew hill were covered with tea-plants. "The flowers of the tea on the hills are of a pleasant, delicate fragrance, unlike the smell of other tea-plants; but the leaves and fruit appear the same. This would be a delightful place for the manufacture of tea, as the country is well populated, has abundance of water, and grain is cheap. There is a small stream called the Jhaugy river, at a distance of two hours walk: it is navigable all the year round for small canoes, which would carry down the tea, and the place is only one and a half day's journey from Jorehaut, the capital of Upper Assam." South-west of Gabrew Purbet, (about two days journey,) is a village inhabited by a race called Norahs, who came from the eastward, where tea abounds. The oldest man in this village told Mr. Bruce, that when his father was a young man, he had emigrated, with many others, and settled at Tipum, opposite Jaipore; that they brought the tea-plant with them, and planted it on the Tipum hill, where it exists to this day; and that when he was about sixteen years of age, he was compelled to leave Tipum, on account

of wars and disturbances, and take shelter at the village where he now resides. This man said he was eighty years of age, and his father died a very old man. He was the only man met by Mr. Bruce in his journeys who could give him any account of the tea-plant, with the exception of an Ahum, who declared that it was Sooka, or the first Kacharry Raja of Assam, who brought the tea-plant from Munkum—he said it was written in his Putty, or history. Mr. Bruce found the old Norah man's story true; for the superintendent cleared the tract where it grew thickest, about 300 yards by 300: the old man said his father cut the plant down every third year, that he might get the young leaves

The Report is accompanied by a map of Muttuck, Singpho, and the country west of the Boree Dibing river, showing all the tea-tracts that have been discovered; they are distributed all over the district. Mr. Bruce does not pretend to say how much tea they would all produce if fully worked. Until lately, he had only two Chinese black tea makers. These men have native assistants; each Chinaman, with six assistants, can only superintend one locality, and the tea-leaves from the various other tracts, widely separated, must be brought to these two places for manufacture. Hence, additional labourers must be always employed to bring the leaves from so great a distance: the leaves, too, in the journey, soon begin to ferment, and the labour of only preparing them so far in process that they may not spoil by the morning is excessive. The men have often to work very late, and consequently the labour is not so well executed; the leaves last gathered are also much larger than they ought to be, for want of being collected and manufactured earlier—consequently the tea is of inferior quality. This is mentioned to show the inconvenience and expense of having so few tea-makers—a disadvantage which may interfere with the success of the experiment. Mr. Bruce considers that it will not become sufficiently forward to be transferred to speculators, until a sufficient number of native tea-manufacturers have been taught to prepare the black and green sorts; then, under 100 available tea-manufacturers, it would be worth while to take up the scheme on a large scale. Labourers must be introduced, in the first instance, to give a tone to the Assam opium-eaters; but the great fear is, that these latter would corrupt the new comers. If the cultivation of tea were encouraged, and the poppy put a stop to in Assam, the Assamese would make a splendid set of tea-manufacturers and tea-cultivators.

In estimating the extent of the tea-tracts, Mr. Bruce only refers to those patches of plants which grow thickly together, and does not reckon the straggling plants in the forest and jungle. The former are so thick as to impede each other's growth; and by thinning them, a sufficient number of plants may be found to fill up the patches of jungle between the present tracts. Yet many tea-tracts have been cut down, in ignorance, by the natives, to make room for the rice-field, for fire wood, and fences. Many of these tracts have sprung up again, more vigorous than before.

Mr. Bruce considers that in Assam, as in China, the hilly tracts produce the *best* teas. In the low land, the plants seem to love and court moisture, not from stagnant pools, but running streams. The Kuhung tracts have the water in and around them, and are all in heavy tree-jungles. An extent of 300 yards by 300 will cost from 200 to 300 rupees, clearing, *i. e.* according to the manner in which the miserable opium-smoking Assamese work. They will not permit their women to come into the tea-gardens; whereas, females and children might be profitably employed in plucking and sorting leaves. But the gathering is hard work—the standing in one position so many hours occasions swelling in the legs; as the Assamese plants are not like those of China, only three feet high, but double that size, so that one must stand upright to pluck the leaves. The Chinese gather theirs squatting down. The Assamese trees will, probably, become of a smaller and more convenient size after a few years' cultivation; from trimming the plants, taking all their young leaves as soon as they appear, and from the soil being poorer. Transplanting, also, helps to stunt and shorten their growth. The Chinese assured Mr. Bruce, that the China plants, now of Deenjoy, would never have attained half their present perfection under ten years in their own country.

The sun materially affects the leaves; for, as soon as the trees that shade the plants are removed, the leaf loses its fine deep green, and turns yellowish; but it at length changes to a healthy green, and becomes thicker than when in the shade. The more the leaves are plucked, the greater number of them are produced. The plants in the sun have flowers and fruit much earlier than those in the shade; flowers and seeds in July, and fruit in November. Some plants, by cold or rain, having lost all their flowers, throw out buds more abundantly than ever. Thus, plants may be seen in flower so late as March, (some of the China plants were in flower in April,) bearing the old and the new seeds, flower-buds, and full-blown flowers, all at one and the same time. The rain, also, greatly affects the leaves, for some sorts of tea cannot be made in a rainy day; for instance, the *Powchong* and *Mingehew*. The leaves for these ought to be collected about 10 A. M. on a sunny morning, when the dew has evaporated. The *Powchong* can only be manufactured from the leaves of the first crop; but the *Mingehew*, although it requires the same care in making as the other, can yet be made from any crop, provided the morning be sunny. The Chinese dislike gathering leaves on a rainy day for any description of tea. Some pretend to distinguish the tea imade on a rainy day from that made on a sunny day, much in the same manner as they can distinguish the shady from the sunny teas, by their inferiority. If the large leaves for the black tea were collected on a rainy day, about seven seers, or fourteen pounds, would be required to make one seer, or two pounds, of tea; but if collected on a sunny day, about four seers, or eight pounds, of green leaves, would make one seer, or two pounds, of tea: so the Chinamen told Mr. Bruce; and from experiment he found their statement correct. The season for tea-making generally commences about the middle of March; the second crop in the middle of May; and the third about the middle of July; but the time varies according to the rains setting in sooner or later.

We now arrive at near the number of tea-plants cultivated in Assam. The China black tea-plants which were brought into Muttack, in 1837, amounted to 1609, healthy and sickly; and they mostly flourish as well as if reared in China. Mr. Bruce collected about twenty-four pounds of the China seeds, and sowed some on the little hill of Tipum, in his tea-garden, and others in the nursery-ground at Jaipore; about 3,000 of which have come up, are looking beautiful, and doing very well; but the

China seedlings on Tipum hill have been destroyed. The Assam and China seedlings are near each other; the latter have a much darker appearance—there may be about 10,000 of them. In June and July, 1837, 17,000 young plants were brought from Muttack, and planted out in thick tree jungles. Six or eight thousand had previously been planted there; many of these died in consequence of the buffaloes constantly breaking in among them; but the rest are doing well, though in jeopardy of the above enemies.

In 1838, 52,000 young tea-plants were brought from about ten miles distance from Jaipore; a great portion of these have been sent to Calcutta, to be forwarded to Madras. Should they thrive there, it is Mr. Bruce's opinion that they will never attain the height of the Assamese plants, but be dwarfish like the Chinese. Transplantation should be done in the rains, when very few, if any, will die, provided, also, that they are removed from one sunny tract to another. Mr. Bruce believes the tea-plant to be so hardy that it would live almost in any soil, if it were only planted in deep shade when taken to it. The roots should be well watered, but not inundated; when they have taken hold, the shade should be removed. From moderately-sized plants, removed from the jungle to a garden, a small crop of tea may be gathered next year. From plants raised from seed, a crop may be expected the third year; they reach maturity in six years, and live forty or fifty.

METALLOCHROMY.

(To the Editor.)

Sir.—In experimenting upon this subject, I find that platina may be colored similarly to steel, by employing a solution of sulphate of manganese. The colors are even more beautiful than those produced on steel, but the rings are much smaller. The positive wire must slightly touch the platina foil. I have tried a steel plate also in the same solution, and find that colors may be produced on it in a slight degree.

The battery made use of was a Grove's battery of two small jelly jars.

Trusting that it may afford some information to your readers I have troubled you with this account.

JOHN SAVAGE.

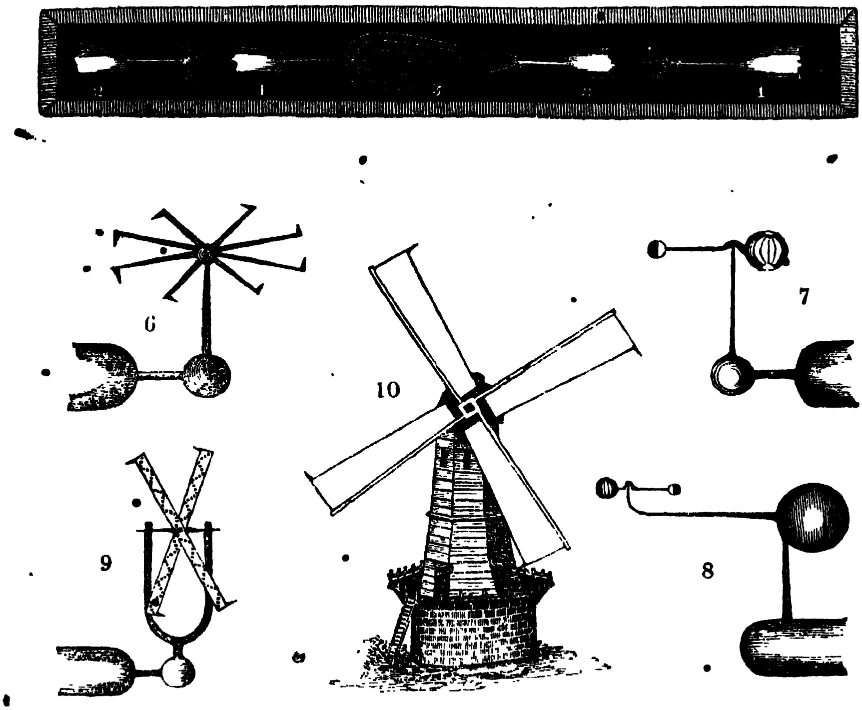
MISCELLANIES

Crystallized Ornaments, Alum Baskets, &c.—Dissolve 2 lbs. of alum in a quart of hot water, pour it into a jar, and immerse in it one of the following or any similar articles, and there let it remain till cold, when it will be found that the alum has been deposited upon the object immersed in it in the shape of the most beautiful white crystals. The objects may be either some twigs of a tree, covered loosely with worsted, or else a frame-work made of brass wire, and covered in the same way: it may represent a basket, crown, church, or in fact any thing that the taste of the maker can suggest. When immersed in the alum water it must be wholly covered with the liquid, and should not touch the bottom of the vessel. It may be colored by boiling up with the alum logwood or orchill, for purple. Brazil wood or red cabbage, for red. Turmeric or saffron, for amber. Gamboge or weld, for yellow. Sap green, Prussian blue, indigo, alkanet root, &c. &c., for the colors they yield; but if blue is desired, instead of alum, use the sulphate of copper or blue stone.

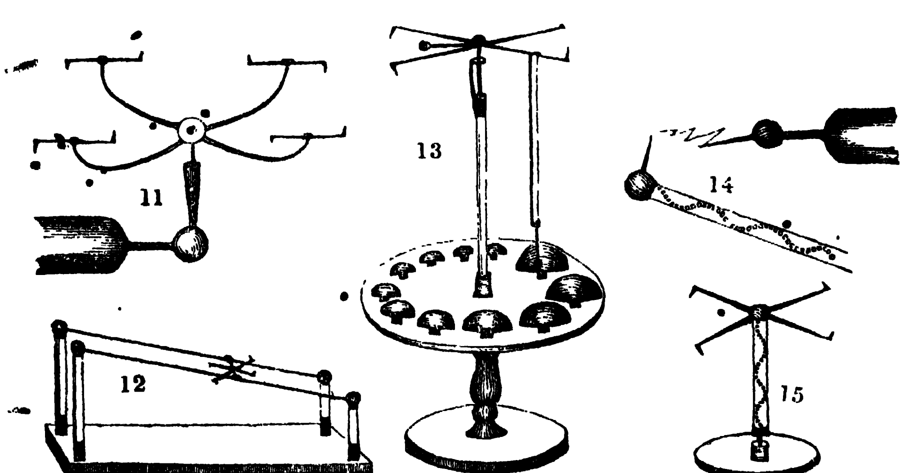
Effects of Mushrooms on the Air.—According to Dr. Mariet, mushrooms produce very different effects upon atmospheric air from those occasioned by green plants under the same circumstances; the air is promptly vitiated, both by absorbing oxygen to form carbonic acid, at the expense of the vegetable carbon, or by the evolution of carbonic acid immediately formed; the effects appear to be the same both day and night. If fresh mushrooms be kept in an atmosphere of pure oxygen gas, a large proportion of it disappears in a few hours. One portion combines with the carbon of the vegetable to form carbonic acid, and another is fixed in the plant, and is replaced by azotic gas disengaged from the mushrooms. When fresh mushrooms are placed for some hours in an atmosphere of azotic gas, they produce but little effect upon it. A small quantity of carbonic acid is disengaged, and in some cases a little azote is absorbed.—*Philos. Mag.*

Reduction of Metallic Poisons—Arsenics.—Gobel has found that formate of soda furnishes the most ready means of reducing metallic poisons, not only when in the state of oxides, but as sulphurets, and is, therefore, of extreme importance in researches connected with medico-legal inquiry. The substance to be examined is mixed with the formate and heated in the usual manner in a small glass tube, over the flame of a lamp; the arsenic, if present, of course, sublimes. In this way Gobel has detected the presence of orpiment in the golden sulphuret of antimony, when present only in the proportion of one part to 1,000 of the antimonial sulphuret.—*Jahres — Bericht der Phys. Wissenchaften; Philos. Mag.*

Mode of preventing Beer from becoming acid.—A patent has been taken out, in America, for preserving beer from becoming acid in hot weather, or between the temperatures of 74° and 94°. To every 174 gallons of liquor, the patentee, Mr. Storewell, directs the use of 1 lb. of raisins, in the following manner:—"Put the raisins into a linen or cotton bag, and then put the bag containing the raisins into the liquor before fermentation; the liquor may then be let down at 65°, or as high as 70°. The bag containing the raisins must remain in the vat until the process of fermentation has so far advanced as to produce a white appearance or scum all over the surface of the liquor, which will probably take place in about 24 hours. The bag containing raisins must then be taken out, and the liquor left until fermentation ceases. The degree of heat in the place where the working vat is situated should not exceed 66°, nor be less than 60°." To prevent distiller's wash from becoming acid, 2 lbs. of raisins should be put into 150 gallons of the wash, the raisins being chopped and put in without a bag; and 106 gallons of hops should then be put into the wash vat for every eight bushels of malt at the time of washing, and three-quarters of a pound of hops for every bushel of malt brewed, to be boiled on in the liquor in the copper.—*Journal of the Franklin Institute of America.*



INFLUENCE OF POINTS IN ELECTRICITY.



ELECTRICITY.

(Resumed from page 51.)

Every person who is accustomed to or acquainted with the use of an electrical machine, is aware of the very great difference of appearance and effect of a ball and a point when electrified. The fluid passes from or to a ball in a spark or sudden flash —from or to a point it proceeds silently, gradually, and in many cases imperceptibly, even when in the greatest quantity, being seen on the point only like a star, or a brush of light. Also, it is well known that a point attracts the fluid from a much greater distance than a ball does—and also in much greater quantity. These facts have given rise to very numerous highly interesting experiments, and also direct us how to accumulate, retain, or disperse the electrical fluid with the greatest facility and certainty, at the same time proving the laws by which the different appearances are observed, and also showing the application of them equally to purposes of amusement, instruction, and utility.

Ex. 16.—Hold a sharp needle at a few inches distance from a charged conductor, and try with the other hand to take a spark; it will be found that a spark will not pass to the hand until the needle is withdrawn, although the needle may have been held at double the distance at which the spark would otherwise have flown across. This experiment shows that during the working of a machine no sharp points or edges must be any where around it, or they will all tend to draw off some portion of the fluid. So also it is requisite that every part of the electrical machine, and most electrical apparatus, must be made with well-rounded edges, and without sudden prominences or projections of any kind. Every thing of this kind must be well freed from dust when in use, as every particle is a point conducting away the fluid: and not merely on the articles and table around, but still more especially from the working part of the machine itself, as is proved by the following.

Ex. 17.—Place a pointed wire on the prime conductor, turn the cylinder, and the whole fluid produced will be dissipated by the point. Thus females, when electrified by being placed on a glass stool, seldom give so strong a spark as male persons, because of the pins in their dress, or their hair; the edges of their garments, broaches, ear-rings, &c., being like so many conducting points, which men's dress is more free from. Let it be remarked, however, that points when covered up have not this tendency to dissipate the fluid which charges them.

Ex. 18.—In the last experiment the point having been fastened to the prime or positive conductor, gives off the fluid in the shape of a brush of light, as in Fig. 1; but if it be placed on the negative conductor or cushion, its chain being removed, it will appear like a star, as in Fig. 2. This is seen also by either of the following methods:—

Ex. 19.—Take away the chain of the cushion, and place a pointed wire, a foot or more long, in a hole made on the top of that cushion, and also another similar wire on the top of the conductor; let the points of these respective wires approach to within a foot or less of each other, when upon turning the machine a brush of light will appear upon the one, and a star upon the other.

Ex. 20.—If the cushion of the machine be not adapted for the purpose, hold its wire in the hand towards the other wire, and the same appearance will be exhibited.

The cause of this is easily explained. The positive wire is giving off the fluid, the negative wire is receiving it, (See Figs. 3, 4, and 5.) The fluid passes from 3 with considerable impetus or force, and as the particles of electric matter repel each other, it does not pass in a regular dense stream from 3 to 4, but diverges into a brush. It is prevented, however, from diverging too far in consequence of the attractive power of the negative point 4, where the rays of fluid are again collected. Were there no other force in action than equal attraction on the negative side, and repulsion on the positive, the arc of fluid from one to the other point would be spindle-shaped, as it is in galvanism; but in free electricity the repulsion from the positive side is much greater than the attractive force on the negative side—thus the fluid issuing from No. 3 acquires a considerable impetus or momentum, which carries it in some degree beyond the negative point, before it enters, (as is represented by the dotted lines 5;) hence the cause of the brush and the star of light.

Ex. 21.—*Electric Flyer.*—Place upon the conductor a pointed wire, and balance upon this a cross or star of wires, every ray of which is bent towards the end in the same direction, as represented in Fig. 6. The fluid issuing from these various points will turn the star of wires round in the opposite direction.

Ex. 22.—*Small Orrery.*—Instead of the flyer in the last experiment, support a small orrery, made as in Fig. 7, with a single point near the end projecting sideways; this also will turn round and exhibit the motion of the moon round the earth.

Ex. 23.—*Electric Orrery.*—This apparatus is seen in Fig. 8. It represents the sun, earth and moon. The earth and moon are formed exactly as in the last experiment; they are balanced at their centre of gravity, upon a pointed wire, bearing at its other end the sun; this wire has a point projecting *sideways* near its farthest extremity. The moon also bears a side point, thus (every part being nicely balanced) the earth and moon revolve round each other, and both together round the sun—making one of the best possible illustrations of the real motions of these heavenly bodies. The whole apparatus may be six inches long; the sun, &c. may be of wood.

Ex. 24.—*Electrical Cross.*—Form a cross of two thin pieces of glass, and paste upon them spots of tin-foil, just or nearly touching each other, and with a wire point at each end, support this very nicely, as represented in Fig. 9. Turn the machine, when the fluid passing from the centre to each of the points will produce beautiful streams of light, constantly in motion in consequence of the rotation of the cross. *Note.*—This cross may be made horizontal instead of vertical.

Ex. 25.—Make a windmill of card-board or baked wood varnished, up its centre put a wire, the lower end of which may fit a hole in the conductor; the upper end must support a needle put crossways, so that its point projects through the head of the mill, ready to bear the sails. Make the sails of paper, with a fine wire running along the back and end of each, a point of it projecting beyond the other side. (See Fig. 10.) Let the centre of these sails be a small ball of metal, or else wood or pith gilt; fix the sails in this ball, and place the whole upon the point of the needle. Upon turning the machine, the mill will revolve rapidly. This apparatus may

be across the sails from one extremity to the other, 4 or 5 inches, the other parts in proportion.

Ex. 26.—*Compound Flyer, Round-about, &c.*—A number of flyers may be made to revolve at the same time, if made very light, and delicately supported; an arrangement of this kind is seen in Fig. 11. A number of similar contrivances may be made as a round-about, such as is seen at fairs, provided the points which are to give it motion are properly placed—one among these is

Ex. 27.—*The Electrical Inclined Plane.*—(See Fig. 12.)—In which a flyer is furnished with a small grooved pulley at each end of an axis that bears it, it is placed on two wires which are supported by glass; when this is connected with a moderately powerful machine, the flyer immediately begins to turn round, and traverses up the wires.

Ex. 28.—*Electric Flyer with Bells.*—This apparatus is represented in Fig. 13. It consists of a stand with differently-toned bells arranged upon it, the centre is a glass rod, and this supports a flyer, which flyer has dependent from one of its arms a wire and a silk string bearing a brass ball, (the only use of the wire is to keep the string somewhat steady, also the fifth arm of the flyer bearing a ball is merely a counterpoise for the weight of the wire and string.) To use it, take away the conductor of the machine, and put the flyer in the same place as the points of the conductor usually are, when it will turn round, and the ball striking against them, of course rings the bells.

Ex. 29.—Hold towards the ball of a charged conductor a spiral tube (Fig. 14.) furnished with a ball at the end, and contrary to the usual character of a point, it will take a spark; this is owing to the interrupted nature of the conductor which connects the point with the hand or with the ground.

Ex. 30.—Support a spiral tube on a point, as represented in Fig. 15, and have a flyer affixed to the upper end; connect it with a charged prime conductor, when the fluid passing away from the points turns the spiral on its axis.

(*Continued on page* 161.)

PREVENTING THE DECAY OF WOOD.

The following is extracted from a paper read by Dr. Parry, of Bath, before the Society of Arts:—

It appears that the contact of water and air are the chief causes of the decay of wood. If, therefore, any means can be devised, by which the access of moisture and air can be prevented, the wood is secure against decay. This principle may be illustrated by supposing a cylinder of dry wood to be placed in a glass tube or case, which it exactly fills, and the two ends of which are, as it is called, hermetically sealed, or entirely closed. Who will doubt that such a piece of wood might remain in the open air a thousand years unchanged? Or let us take a still more opposite illustration of this fact—that of amber, a native bitumen, or resin, in which a variety of small flies, filaments of vegetables, and others of the most fragile substances, are seen embedded, having been preserved from decay much longer, probably, than a thousand years, and with no apparent tendency to change for ten times that period.

To exclude air and moisture, various experiments have been employed, of which the most common is covering the surface with paint; which is oil mixed with some substance capable of giving it the color which we desire. It is well known that several of the oils, as those of linseed, hemp-seed, &c., become dry when thinly spread on any hard substance. The drying quality is much assisted by being previously boiled with certain metallic oxides, more especially that of lead, or litharge. The crust so formed is with difficulty penetrated by moisture or air. For this purpose, also, drying oil is spread on silk or linen, in the manufacture of umbrellas, &c.

When paint is employed within doors, it is customary to add to the oil, besides the coloring matter, some essential oil of turpentine, which not only makes it dry more readily, but, by giving it greater tenuity, causes it to flow more freely from the brush, and therefore to go farther in the work. For the same purpose it forms a part of the paint used on wood and iron work in the open air, but most improperly; for on rubbing wood painted white, and long exposed to the weather, the white lead comes off in a dry powder like whiting; as if the vehicle which glued it to the wood had been decomposed and lost, leaving only the pigment behind.

The composition, which experience has proved to be the best adapted for the preservation of wood from both species of decay, (viz. the wet and dry rot,) is as follows:—Melt twelve ounces of rosin in an iron pot or kettle; when melted, add eight ounces of roll brimstone, and just when both are in a liquid state, pour in three gallons of train, or whale oil. Heat the whole slowly, gradually adding four ounces of bees' wax cut into small bits, frequently stir the mixture, and as soon as the solid ingredients are dissolved, add as much Spanish brown, or red or yellow ochre, or any other color, (first ground fine with some of the oil,) as will give the whole a deep shade. It will now be fit for use. Lay on this paint or varnish as hot and thin as possible; and some days after the first coat becomes dry, give a second. These coats will preserve planks, &c., for ages. What remains unused will become solid on cooling, and may be remelted for future occasions. Dr. Parry used some of this composition on elm-paling, which, eighteen years after, was as sound as when first put up.

All the substances contained in this mixture are capable of perfect incorporation with each other by heat, and when separately exposed, are with great difficulty acted on by water or air in any heat which occurs in our climate. They should be applied hot with a common painter's brush on the wood which is previously very dry, so as to sink deeply into its pores; and though at first they are apparently somewhat greasy when cold, yet after some days they make a firm varnish, which does not come off on rubbing. When it is required to give beauty to the work, coloring matters may either be added to the mixture, or afterwards applied over it in form of common paint. Two coats of the composition should always be given; and in all compound machinery, the separate parts should be so varnished before they are put together; after which it will be prudent to give a third coating to the joints, or to any other part which is peculiarly exposed to the action of moisture, such as water-shoots, flood-gates, the beds of carts, the tops of posts and rails, and all timber which is near or within the ground. Each coat should be dry before the parts are joined, or the last coat applied.

This composition will also prevent iron and other metals from rusting.

It is necessary to mention, that compositions made of hot oil should, for the sake of security, be heated in metallic or glazed earthen vessels, in the

open air. For whenever oil is brought to the boiling point, or 612 degrees of Fahrenheit's thermometer, the vapour immediately catches fire, although not in contact with any flame: now though a lower degree of temperature than that of boiling should be used in this process, it is not always practicable either exactly to regulate the heat, or to prevent the overflowing of the materials; in either of these cases, were the melting performed in a house, the most fatal accidents might follow.

Preservation of Wood by Charcoal.—The following mode of preventing rottenness in pales, water-shoots, &c., is also recommended by Dr. Parry, who says:—

"More than thirty years ago this subject presented itself to my mind, on seeing some water-shoots, which had been pitched and painted in the common way, taken down in a state of complete rotteuness. I had read that charcoal buried in the moist earth, had come down to us perfectly sound from the times of the Romans; and that posts long withstood the same moisture, if the part intended to be put into the ground was charred all round to a certain depth. Impressed with this fact, I determined to try an artificial coating of charcoal, and when new water-shoots were constructed, I strongly and carefully rubbed them with a coat of drying oil, which I immediately dredged all over with a thick layer of *charcoal* finely powdered, and contained in a muslin bag. After two or three days, when the oil was thoroughly dried, and firmly retained the greatest part of the charcoal, I brushed off what was loose, and over that which adhered I applied a coat of common lead-colored paint, and a few days after, a second. The whole became a firm and solid crust; after which the shoots were put in their places, and being examined many years afterwards, appeared perfectly sound. Any other color would probably have succeeded equally well with that which I employed. I do not think that lamp black, which is a pure species of charcoal, would have answered the purpose of forming a thick defensive covering so well as the grosser charcoal which I used. But whatever sort of charcoal is employed, it ought either to be *fresh made, or heated again in close vessels, so as to expel the water* which it greedily attracts from the air. It is to be observed here, that the practice of pitching pales, &c., is both incommodious and inefficacious, as pitch is so liable to be melted by the heat of the sun."

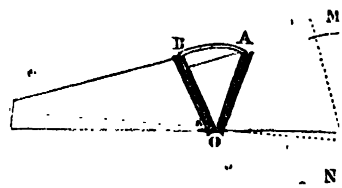
THE SINGLE KALEIDOSCOPE.

ITS CONSTRUCTION AND USE.

In order to construct the kaleidoscope in its most simple form, we must procure two reflectors, about five, six, seven, or eight inches long. These reflectors may be either rectangular plates, or plates shaped like those represented in Fig. 1, having their broadest ends A O from one to two inches wide.

If the reflectors are of glass, the newest plate glass should be used, as a great deal of light is lost by employing old plate glass, with scratches or imperfections upon its surface. The plate glass may be either quick-silvered or not, or its posterior surface may be ground, or covered with black wax, or varnish, or any thing else that removes its reflective power. This, however, is by no means absolutely necessary; for if the eye is properly placed, the reflections from the posterior surface will scarcely affect the distinctness of the picture, unless in very intense lights. If it should be thought necessary to extinguish as completely as possible all extraneous light that may be thrown into the tube from the posterior surface of the glass plates, that surface should be coated with a varnish of the same refractive and dispersive power as the glass.

Fig. 1.



If the plates of glass have been skilfully cut with the diamond, so as to have their edges perfectly straight and free from chips, two of the edges may be placed together, as in Fig. 1, or one edge of one plate against the corresponding edge of the other. But if the edges are rough and uneven, one of them may be made quite straight and free from all imperfections, by grinding it upon a flat surface with very fine emery, or with the powder scraped from a hone. When the two plates are laid together, so as to form a perfect junction, they are then to be placed in a brass or any other tube, so as to form an angle of 45°, 36°, 30°, or any even aliquot part of a circle. In order to do this with perfect accuracy, direct the tube containing the reflectors to any line, such as M N, placed very obliquely to one of the reflectors A O, and open or shut the plates till the figure of a star is formed, composed of 8, 10, or 12 sectors, or with 4, 5, or 6 points, corresponding to angles of 45°, 36°, and 30°. When all the points of the star are equally perfect, and none of the lines which form the salient and re-entering angles disunited, the reflectors must be fixed in that position by small arches of brass, A B, filed down till they exactly fit the space between the open ends of the plates. The plates must then be kept in this position by pieces or wedges of cork or wood, or any other substance pushed between them and the tube. The greatest care, however, must be taken that these wedges press lightly upon the reflectors, for a very slight force is capable of bending and altering the figure even of very thick plates of glass.

When the reflectors are thus placed in the tube, as in Fig. 2, their extremities *a* E, *b* E, next the eye, must reach to the very end of the tube, as it is of the greatest importance that the eye get as near as possible to the reflectors.

Fig. 2.

The other ends of the reflectors A O, B O, must also extend to the other extremity of the tube, in order that they may be brought into contact with the objects which are to be applied to the instrument. In using transparent objects, the cell which contains them may be screwed into the end of the tube, so as to reach the ends of the reflectors, if they happen to terminate within the tube; but an

instrument thus constructed is incapable of being applied to opaque objects, or to transparent objects seen by reflected light.

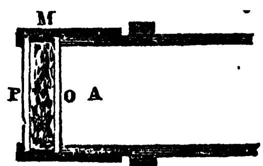
If the plates are narrower at the eye end, as in Fig. 2, the angular point E should be a little on one side of the axis of the tube, in order that the aperture in the centre of the brass cap next the eye may be brought as near as possible to E. When the plates have the same breadth at both ends, the angular point E will be near the lower circumference of the tube, as it is at O; and in this case it is necessary to place the eye-hole out of the centre, so as to be a little above the angular point E. This construction is less elegant than the preceding; but it has the advantage of giving more room for the introduction of a feather, or a piece of thin wood covered with leather, for the purpose of removing the dust which is constantly accumulating between the reflectors. In some instances, the plates have been put together in such a manner that they may be taken out of the tube, for the purpose of being cleaned; but though this construction has its advantages, yet it requires some ingenuity to replace the reflectors with facility, and to fix them at the exact inclination which is required. One of the most convenient methods is to support the reflector in a groove cut out of a solid cylinder of dry wood of nearly the same diameter as the interior diameter of the tube; and after a slip of wood, or any other substance, is placed along the open edges of the plates, to keep them at the proper angle given by the groove, the whole is slipped into the tube, where it remains firm and secure from all accident.

If the length of the reflectors is less than the shortest distance at which the eye is capable of seeing objects with perfect distinctness, it will be necessary to place at the eye at E a convex lens, whose focal length is equal to, or an inch or two greater than, the length of the reflectors. By this means the observer will see with perfect distinctness the objects placed at the object end of the kaleidoscope. This lens, however, must be removed when the instrument is to be used by persons who are short-sighted.

The proper application of the objects at the end of the reflectors is now the only step which is required to complete the simple kaleidoscope. The method of forming, selecting, and mixing the objects will be described hereafter. At present we shall confine our attention to the various methods which may be employed in applying them to the ends of the reflectors.

The first and most simple method consists in bringing the tube within half an inch beyond the ends of the reflectors. A plane lens, of the same diameter as the tube, is then pushed into the tube, so as to touch the reflectors. The pieces of colored glass being laid upon this lens, another plane lens, having its upper surface ground with fine emery, is next placed above the glass fragments, being prevented from pressing upon them, or approaching to the first plane lens, by a ring of copper or brass; and is kept in its place by burnishing down the end of the tube. The eye being placed at the other end of the instrument, the observer turns the whole round in his hand, and perceives an infinite variety of beautiful figures and patterns, in consequence of the succession of new fragments which are brought opposite the aperture by their own gravity, and by the rotatory motion of the tube. In this rude state, however, the instrument is by no means susceptible of affording very pleasing exhibitions. A very disagreeable effect is produced by bringing the darkest sectors, or those formed by the greatest number of reflections, to the upper part of the circular field; and though the variety of patterns will be very great, yet the instrument is limited to the same series of fragments, and cannot be applied to the numerous objects which are perpetually presenting themselves to our notice. These evils can be removed only by adopting the construction shown in Fig. 2, in which the reflectors reach the very end of the tube. Upon the end of the tube A, Fig. 3, is placed a ring of brass, M N, which moves easily upon the tube A, and is kept in its place by a shoulder of brass on each side of it.

Fig. 3.



A brass cell, M N, is then made to slip tightly upon the moveable ring, so that when the cell is turned round by means of the milled end, at M N, the ring may move freely upon the tube. The fragments of colored glass, &c., are now placed in a small box, or *object plate*, as it may be called, consisting of two glasses, one transparent and the other ground, kept at the distance of one-eighth or one-tenth of an inch by a brass rim. This brass rim generally consists of two pieces, which screw into one another, so that the object plate can be opened by unscrewing it, and the fragments changed at pleasure. This object plate is placed at the bottom of the cell M N, as shown at O P, and the depth of the cell is such as to allow the side O to touch the end of the reflectors, when the cell is slipped upon the ring. When this is done, then the instrument is held in one hand with the angular point E downwards, (Fig. 2,) which is known by a mark on the upper side of the tube *a* and *b*, and the cell is turned round with the other, so as to present different fragments of the included glass before the aperture A O B. The tube may be directed to the brightest part of the sky in the day-time, or in the evening to a candle or an Argand lamp, so as to transmit the light directly through the colored fragments; but it will always be found to give richer and more brilliant effects if the tube is directed to the window shutter, a little to one side of the light, or is held to one side of the candle—or, what is still better, between two candles or lamps placed as near each other as possible. In this way the picture created by the instrument is not composed of the harsh tints formed by transmitted light, but of the various reflected and softened colors which are thrown into the tube from the sides and angles of the glass fragments.

In the preceding method of applying the objects to the reflectors, the fragments of colored glass are introduced before the aperture, and pass across it in concentric circles; and as the fragments always descend by their own gravity, the changes in the picture, though infinite in number, constantly take place in a similar manner. This defect may be remedied, and a great degree of variety exhibited in the motion of the fragments, by making the object plates rectangular instead of circular, and moving

them through a groove cut in the cell at M N, in the same manner as is done with the pictures or sliders for the magic lanthorn and solar microscope. By this means the different fragments that present themselves to the aperture may be made to pass across it in every possible direction, and very interesting effects may be produced by a combination of the rotatory and rectilineal motions of the object plate.

When the simple kaleidoscope is applied to opaque objects, such as a seal, a watch-chain, the second's-hand of a watch, coins, pictures, gems, shells, flowers, leaves, and petals of plants, impressions from seals, &c., the object, instead of being held between the eye and the light, must be viewed in the same manner as we view objects through a microscope, being always placed as near the instrument as possible, and so as to allow the light to fall freely upon the object. The object plates, and all transparent objects, may be viewed in this manner: but the most splendid exhibition of this kind is to view minute fragments of colored glass, and objects with opaque colors, &c., placed in a flat box, the bottom of which is made of a glass mirror. The light reflected from the mirror glass, and transmitted through the transparent fragments, is combined with the light reflected both from the transparent and opaque fragments, and forms an effect of the finest kind.

(Continued on page 139.)

DISCOVERY OF THE MARINER'S COMPASS.

Much interest must for ever attach to the discovery of this instrument, and yet there are few subjects concerning which less is known. For a long period, the honour of the invention was ascribed to Gioia, a pilot, or ship's captain, born at Pasitano, a small village situated near Malphi, or Amalfi, about the end of the thirteenth century. His claims, however, have been disputed. According to some, he did not invent, but improve it; and according to others, he did neither. Much learning and labour have been bestowed upon the subject of the discovery. It has been maintained by one class, that even the Phœnicians were the inventors; by another, that the Greeks and Romans had a knowledge of it. Such notions, however, have been completely refuted. One passage, nevertheless, of a very remarkable character, occurs in the work of Cardinal de Vitty, Bishop of Ptolemais, in Syria. He went to Palestine during the fourth crusade, about the year 1204; he returned afterwards to Europe, and subsequently went back to the Holy Land, where he wrote his work entitled "Historia Orientalis," as nearly as can be determined, between the years 1215 and 1220. In chap. xci of that work he has this singular passage:—"The iron needle, after contact with the loadstone, constantly turns to the north star, which, as the axis of the firmament, remains immoveable, whilst the others revolve; and hence it is essentially necessary to those navigating on the ocean." These words are as explicit as they are extraordinary; they state a fact, and announce a use. The thing, therefore, which essentially constitutes the compass, must have been known long before the birth of Gioia. In addition to this fact, there is another equally fatal to his claims as the original discoverer: it is now settled beyond a doubt, that the Chinese were acquainted with the compass long before the Europeans. It is certain that there are allusions to the magnetic needle in the traditionary period of Chinese history, about 2600 years before Christ; and a still more credible account of it is found in the reign of Chingwang, of the Chow dynasty, before Christ 1114. All this, however, may be granted, without in the least impairing the just claims of Gioia to the gratitude of mankind. The truth appears to be this: the position of Gioia, in relation to the compass, was precisely that of Watt in relation to the steam engine—the element existed, he augmented its utility. The compass used by the mariners in the Mediterranean, during the twelfth and thirteenth centuries, was a very uncertain and unsatisfactory apparatus. It consisted only of a magnetic needle floating in a vase or basin by means of two straws or a bit of cork supporting it on the surface of the water. The compass used by the Arabians, in the thirteenth century, was an instrument of exactly the same description. Now the inconvenience and inefficiency of such an apparatus are obvious; the agitation of the ocean, and the tossing of the vessel, might render it useless in a moment. But Gioia placed the magnetized needle on a pivot, which permits it to turn on all sides with facility. Afterwards it was attached to a card, divided into thirty-two points, called Rose de Vents; and then the box containing it was suspended in such a manner, that however the vessel might be tossed, it would always remain horizontal. The result of an investigation participated in by men of various nations, and possessing the highest degree of competency, may thus be stated. The discovery of the directive virtue of the magnet was made anterior to the time of Gioia. Before that period, navigators, both in the Mediterranean and Indian seas, employed the magnetic needle; but Gioia, by his valuable improvement in the principle of suspension, is fully entitled to the honour of being considered the real inventor, in Europe, of the compass as it now exists.

ANIMALCULES.

BY DR. GRANT.

"On the recent Discoveries and History of Animalcules;" creatures living, so infinitely small, that the mentioning of their size subjects a lecturer, in the minds of many of his hearers, to a charge of inaccuracy, or, perhaps, of worse. Still is it not the les true that animated beings of marvellous minuteness exist; that millions of animalcules live in a single drop of water; and that these creatures are of a complicate structure, and closely allied to animals of a higher class. They are various in species, possessing relatively cerebral ganglia, respiratory, visual, masticating organs, &c., and stomachs, to the number of 150 in one animalcule. They abound in pools, in rivers, extensively in the ocean, and in all waters on the surface of the globe; also in waters in mines, in water-percolating rocks, where no ray of light penetrates. Countless thousands inhabit mud; and dust, clouds of dessicated earth, contain their millions ready to resume their living state. They are capable of a torpid existence in earth dried up by a summer sun, and hibernate frozen in ice. Poisons, if chemically combined with the water, destroy animalcules, otherwise their particles in any mechanical dissolution are too large to be swallowed; but even in the case of chemical

combination, animalcules often revive after imbibing the strongest poisons. These powerful agents, therefore, have little effect upon these creatures, and the ordinary means of destruction none: but a shock of electricity bursts their bodies and kills them instantaneously. Their increase is astounding. From one individual, in four days, one hundred and forty millions of millions would have existed, sufficient to form two solid cubic feet of siliceous rock. Most of the solid skeletons of *polygastric* animalcules are external siliceous covers which envelop the entire body; they long resist decay, and they exhibit the general form and characters of the species to which they belonged. Both marine and fresh-water species abound in the tertiary deposits of all latitudes, forming alone entire strata, or occurring with the remains of other classes; and they are observed along with the scales of fishes, in the substance of chalk flints, or siliceous porphora of the newest secondary rocks. Their remains form vast deposits and layers of solid stone. This wonder in some measure ceases when merged in the general view of the tertiary and most of the secondary formations. Testaceous rocks, in some instances, of more than 130,000,000 of cubic fathoms in bulk, are composed entirely of shells, the skeletons of molluscous animals. All the limestone of the globe is formed from animal bodies, and chalk contains myriads upon myriads of cephalopods and others. Animalcules, then, are, as before said, the greater portion of siliceous rock; their nature has been revealed by the microscope, and their internal complicate structure fully developed by that instrument, assisted by the patience and ingenuity of experimenters. Substances considered formerly, indeed almost to our own times, mere gelatinous portions of vegetables or zoophytes, have been proved by moderate accurate observers to be distinct animalcules. Coloring matter, carmine put into water, was quickly conveyed into the numerous cavities or stomachs of the animalcules, and thus their whole interior was investigated.

Professor Ehrenberg has published an important work, entitled "The Infusoria, (microscopic animalcules,) as perfect Organisms, a Glance into the Deeper Organic Life of Nature;" with an Atlas of 64 colored plates. In this work, which may be regarded as the summary of Ehrenberg's researches into the *Infusoria*, he arrives at valuable conclusions as to the geographical distribution of the *animalcules*, and establishes two great natural laws: 1, that the animal organization is perfect in all its principal systems, to the extreme limit of vision assisted by the most powerful microscopes; and 2, that the microscopic animalcules exercise a very great and direct influence on inorganic nature. One of the inferences drawn from the first law is the great improbability of these *animalcules*, as well as organic bodies in general, being ever produced by spontaneous generation.

In the *Infusoria* themselves, Professor Ehrenberg has confirmed or first established many very curious qualities and relations, which are highly interesting in a physiological and other points of view, the most important of which we briefly enumerate:

1. Most (probably all) microscopic *animalcules* are highly-organized animals. 2. They form, according to their structure, two well defined classes. 3. Their geographical distribution in the four parts of the world follows the same laws as that of other animals. 4. They cause extensive volumes of water to be colored in different ways, and occasion a peculiar phosphorescence of the sea by the light they develop. 5. They form a peculiar sort of living earth; and, as forty-one thousand millions of them are often within the volume of *one cubic inch*, the absolute number of these *animalcules* is certainly greater than that of all other living creatures taken together; the aggregate volume is even likely to be in favor of the *animalcules*. 6. They possess the greatest power of generation known within the range of organic nature; one individual being able to procreate many millions within a few hours' time. 7. The *animalcules* form indestructible earth, stones and rocks, by means of their siliceous *testæ;* with an admixture of lime or soda, they may serve to prepare glass; they may be used for making floating bricks, which were known to the ancients; they serve as flints, as tripoli, as ochre, for manuring land, and for eating, in the shape of mountain-meal, which fills the stomach with a harmless stay. They are sometimes injurious by killing fish in ponds, in making clear water turbid, and creating miasma; but that they give rise to the plague, *cholera morbus*, and other pestilential diseases, has not been proved. 8. As far as observation goes, the *animalcules* never sleep. 9. They exist as *entozoa* in men and animals, the *spermatazoa* not being taken into consideration here. 10. They themselves are infected with lice as well as *entozoa* (*worms*) and, *on the former, other parasites have been observed*. 11. They are, in general, affected by external agents much in the same manner as the larger organic beings. 12. The microscopic *animalcules* being extremely light, they are elevated by the weakest currents, and often carried into the atmosphere. 13. Those observers, who think they have seen how these minute creatures suddenly spring from inert matter, have altogether overlooked their complicated structure. 14. It has been found possible to refer to certain limits in organic laws, the wonderful and constant changes of form which some of these *animalcules* present. 15. That the organism of these *animalcules* is comparatively powerful, is evinced by the strength of their teeth and apparatus of mastication; they are also possessed of the same mental faculties as other animals. 16. The observation of these microscopic beings has led to a more precise definition of what constitutes an animal, as distinct from plants, in making us better acquainted with the system of which the latter are destitute.

IMPROVED METHOD OF DRYING PLANTS.

(In a Letter addressed to the Editor.)

About five years since I accidentally discovered the following method of drying specimens of plants, and not having seen it mentioned in any work, and also being able to procure finer specimens of plants by this method than by any other I have seen mentioned, I feel desirous of making it public for the benefit of other botanists. The only apparatus necessary is half a ream or a ream of brown paper, and a quire of double-crown cap paper. I have found that size commonly called royal to be the most useful size for the brown paper; it should be tolerably smooth, and that of the weight of 55 lbs. per ream will be the best thickness. The cap paper should be rather loose in its texture, and not too thick; it may be cut into half-sheets, and each of these may be folded. The plan of proceeding will then be this: first, lay down upon a board or table

a quire of the brown paper—lay upon it one of the folded half-sheets of cap paper, between which the plant is to be laid out in the usual way. Then place on it half a quire of the brown paper, and then another half-sheet of cap paper with a plant in it—then another half-quire of brown, and so on till all the specimens are laid in. Finally, place the remainder of the brown paper at the top of the stock. Should the number of specimens requiring to be dried at one time be very great, it may perhaps be sufficient to lay a quarter of a quire between each specimen, though I have never used less than half a quire myself. The time which specimens will require to dry upon this plan, will of course vary, according to the nature of the plant and the dryness of the weather; but in general a week will be sufficient in tolerably fine weather. The great advantage obtained by this plan appears to me to be this: the brown paper being flexible in every direction, exerts an equal pressure on every part of the plant to be pressed; while in the common way of drying plants (a board being used to give the principal pressure) considerable force is exerted on the prominent and more elevated parts of a specimen, such as the stem, &c., while the leaves and thinner parts frequently shrivel in many plants, the thickness of the stem, &c., preventing an adequate pressure from being applied to them. This I have frequently found the case in plants with a woody stem, as Bidens tripartita, Senecio Jacobæa, and aquaticus, Eupatorium cannabinum, &c. Indeed, till I found out the above method, I could never manage to preserve a good specimen of the above and many other plants. I have constantly used this plan for the last five years, and I think that my specimens (preserved by it) will be surpassed by few for beauty.

W. L. NOTCUTT.

PRINCIPLES OF CLASSIFICATION IN THE ANIMAL KINGDOM.

BY PROFESSOR AGASSIZ.

ALTHOUGH the principal groups of animals are impressed with such characters as to be easily recognised and to admit of little doubt, yet their order and succession have been determined by no general principle. This appears from the discrepancy in the positions assigned to them by the most eminent systematists, each of whom has assumed, arbitrarily, some organ or system of organs for the basis of his arrangement. Professor Agassiz (at the last meeting of the British Association), after adverting to some German naturalists who alone have sought after a general principle which should be satisfactory to "philosophic naturalists," passed in review the classes of the animal kingdom, each of which, he stated, exhibited, in an eminent degree, the development of some one of the animal functions. While vertebrate animals (with man, their type) arrive at the greatest perfection in the organs of the senses, the invertebrate offer in the class of worms the representative of the system of nutrition, in *crustacea* of circulation, in insects of respiration, and in *mollusca* of generation. The professor next proceeded to demonstrate in what manner each subclass of vertebrate animals derives its peculiar character from some one element of the animal economy. This predominant element is the bony skeleton in fishes, the muscular structure in reptiles, the sensibility of the nervous system in birds, and the perfection of the senses in *mammalia*, which therefore reproduced the distinguishing character and constitute the type of vertebrate animals. He next showed that each of the other sub-classes of the higher group is represented among the *mammalia* along with its own peculiar type. He explained his reason for the fourfold division which he had adopted in the sub-class, pointing out the close affinity which connects the *ruminantia* the *pachydermata*, the *rodentia*, the *edentata*, and the herbivorous *marsupialia* (in none of which is the true canine tooth developed), which he considers as forming a single group; in another he unites those characterized by the presence of the canine tooth in its proper function (as an instrument of nutrition, not merely of defence), viz. the *carnivora* and those *marsupialia* which partake of their character, and the *quadrumana*. The *cetacea* form a group in themselves, and man another. Man is the perfection and type of the mammiferous conformation.

MISCELLANIES.

Imitative Wax Candles.—Take equal parts of gum benzoin and resin mastic; put each into a separate vessel of glass or lead, add spirit of wine, and heat them gently till the resinous parts are dissolved. Let each of the solutions remain awhile at rest, and then mix them. Before using this varnish, heat it to eighty or ninety degrees Fahrenheit; dip into it a candle from five to ten seconds, and dry it carefully. By this means, common candles may be made to resemble wax lights.

French Phosphoric Matches.—It is well known that phosphoric matches have proved so dangerous as to have been almost totally supplanted by the red or chlorate matches. A safer method of making the former has been devised by the Committee of Health and Safety in Paris. The recipe is as follows: Put a quantity of mucilage of gum arabic into an earthenware vessel, and heat it to the temperature of 100° or 125° Farenheit: to four parts of this mucilage add one part of phosphorus; it will instantly melt, and should be well stirred and well mixed with the mucilage; add chlorate of potash in powder, nitrate of potash, and a little benzoin, to form a soft paste; into which dip the ends of the match sticks. The mass constitutes what is called *fulminating tinder*.

Spirit from the Bilberry.—In the province of Luxemburg, in Belgium, wine, brandy, and vinegar have been made exclusively from the fruit of the bilberry (*vaccinium myrtillus*), a shrub not hitherto turned to any use. This discovery promises to prove of good account in those northern regions in which the bilberry grows abundantly.

Fires in Chimneys prevented.—The principle of Davey's safety-lamp has been successfully applied to prevent fires in chimneys, by M. Maratueh, in France. He has found by experiments, that if three frames of wire-work are placed near the base of the chimney, one above the other, about one foot apart, no flame will pass through them, while the draught of the chimney will not be impaired, and, consequently, no fires can ever happen in the chimney. As most of the soot lodges on the uppermost wire, but little on the second, and none on the third, he suggests that with a brush applied once a day to the lowest or two lowermost, the chimney will never want sweeping.

BEHNES'S SCULPTOR'S INSTRUMENT.

BEHNES SCULPTOR'S INSTRUMENT.

There are few persons who are aware how sculptured busts and other figures in marble are formed, or how the cutting of the stone is managed so as at all times to preserve the exact proportions requisite, that too much may not be cut away, which it is evident would spoil the design, and that a sufficiency may yet be taken off with as little labor to the sculptor as possible.

The following is the process adopted, and the frontispiece of the present number is the best instrument which has been invented for the purpose of the requisite measurement.

First, suppose that it be desired to form a bust in marble similar to a living face; the sculptor would require the individual to be imitated to grant him a certain number of *sittings*, in the same manner as a portrait painter would. These sittings may be in number two, three, four or more, according to circumstances. The sculptor during this time is employed in making a model in common wetted pipe-clay—at the first sitting a rough bust is only made, to give a general idea of the bust which after labor is to complete. It is of course at this time that the size and attitude of the model is decided upon and roughly worked out. This sitting being completed, the model is covered up with a wet cloth, and this is necessary at all times throughout the whole process, even should it last for months, for two reasons: first, because the clay can only be worked while wet, and secondly, if suffered to become dry, it would shrink and crack, and thus afford no criterion afterwards of its original dimensions. At the second and after sittings the accuracy of the whole is increased, until at length the modelled bust has assumed a strong likeness to the original. When this is complete the sculptor no longer requires the presence of the other person; the model serving as a pattern for his further progress—which is as follows:—

The clay model is mounted on a square block of wood or stone, and is so placed that the foot or board upon which it rests is capable of carrying it round an axis, so that the sculptor can move it round, in order to have every part except the top of the head by turns before him, yet without moving the whole from its central position. The block of marble is also fixed upon another foot in precisely a similar manner, it having been hewn into the required form, though considerably larger in diameter than the model, in order to avoid the possibility of too much material being cut away—after this the various superfluous parts must be hewn away with the greatest possible care, and in order that this may be done with complete accuracy, the sculptor uses an instrument of measurement—which instrument is in its moveable parts transferred alternately from the model to the block, and from the block to the model, it being adjusted at each removal as hereafter described.

These instruments are of various kinds, some of extreme simplicity but all upon the same principle of action, as will be readily understood by the following description of the instrument invented by Mr. Behnes, the celebrated sculptor, and which obtained the gold medal of the Society of Arts.

The Figure represents the instrument in use when ascertaining the points upon a clay bust ready to transfer them to a block of marble. Letter E is a semi-circular cast iron bed, fixed immoveably to the stand which supports the model—there is another exactly similar bed fixed in the same manner to the stand, which holds the block of marble, so that the rest of the instrument which fits or screws on at H G, exactly corresponds when removed from the one to the other situation. The cylindrical rod B is capable of motion around G, but when in use is prevented from turning of its own accord by a stud at the back, which fits into one of the holes seen at I, &c., and which holes have correspondent numbers attached to them. The body of the instrument may thus be made firm in any position, whether perpendicular, oblique, or horizontal. H is a cylindrical ferule slit at both ends, in which the rod B traverses, and which therefore enables B to be drawn out more or less according to convenience, B being held fast when adjusted by the screws *h*, *h*, which bind the slits together. The upper extremity M, of the cylindrical tube B, has a cylindrical cavity, into which a stem fits, thereby giving a rotatory motion to the circular limb, and the lesser cylindrical tube C, by which, together with the oblique motions or directions of the greater cylindrical tube B, the sculptor is enabled to take his *points* with the needle perpendicular or in any direction to a plane behind the model or marble, a very decided advantage to sculptors. The rotatory motion at M is stopped by a screw.

D is a circular graduated limb, by which C may be adjusted upon its axis *d* to any position or angle downwards or upwards within 180 degrees from the tube B, it is stopped in its different positions by screwing the check *d* close against the fulcrum of its axis.

N is a smaller cylindrical ferule in which C moves, in the same manner as B does in its ferule H. C being bound tight in its place by the nut at *n*. At O is a ball and socket joint, fixed when necessary by the screw at *x*, this gives the needle or drill P capability of motion or being set to any angle with C, though in its position it is at right angles to it. P is a triangular bar containing the needle point or drill R attached at right angles to a stem inserted into the ball *o*, this triangular bar contains a spring, which keeps the needle or drill moderately tight, thus preventing its dropping out. Q is a triangular socket through which P passes steadily, *q* is a stop fixed upon P by which the distance of the point is defined, and at the same time admits of being drawn back or out of the way of the superfluous marble, until it be sufficiently reduced to admit of the needle point R extending to the distance allowed by the cheek *q*, being the precise point or distance upon the original model obtained upon the marble, which is the object of the instrument.

To use this instrument observe to screw it to the cast iron bed attached to the model, and so adjust it that the point R touches some particular part of the model—then fix the stop *q*, the nuts *x*, *d*, *n*, and *h*, *h*, observing what hole of the bed the stud at the back of H fixes into, then unscrew *q*— transfer the instrument to the block of marble, fix the stud in the corresponding hole, having previously drawn back P. Screw up G so as to make the instrument firm, and chip or drill away the marble until the point R just touches the surface, when *q* touches Q it will be the exact point sought. Proceed in the same manner with several other points, until a sufficiency of measurements have been taken, and the marble bust will of course have been gradually hewn into the required likeness, making the whole art of sculpture a mere mechanical operation.

COPPER IN NATURAL PRODUCTS.

BY M. A. THIEULLEN.

The presence of native copper in various natural products seems to be well demonstrated, and to be no longer doubtful; especially since the appearance of the recent works of M. Devergie and M. Hervey, who have informed the Academy of Medicine that there exist, in the tissues of man and animals, small quantities of copper and lead.

This question has lately been again raised in Belgium, and two different opinions have been formed concerning it.

M. Rotermand is of opinion that it exists in all grains.

M. Koperynschy, who has just published a work on the adulteration of bread, thinks that this metal does not exist in bread; and he says that he has not found any trace of it in grain.

This subject is of the highest importance, especially when it is taken into consideration that small quantities of sulphate of copper have been introduced by some bakers into the dough, at the time of making it into bread, and that investigations are frequently made with the view of detecting the presence of copper arising from this salt.

This question is of still greater importance in Belgium, where the employment of sulphate of copper is at the present time the subject of legal investigations. Although this salt is no longer employed in France, thanks to the measures taken by Government, it is not less true that it would be useful to decide so serious a question, and that investigations should be undertaken by order of the authorities, by men whose names would be a guarantee, and give the force of law to the results of their experiments. This measure is so much the more urgent, as M. Rotermand is not the first who has detected the presence of native copper in organic products, as I shall show, by summing up in few words the experiments made on this subject, which I shall arrange in the order of their dates.

In 1828, M. Boudet informed the *Société de Pharmacie de Paris*, at its sitting of the 15th of March, that M. Vauquelin had announced to the Institute that M. Sarzeau had detected the presence of copper in a great number of vegetables.

M. Vauquelin had already found this metal in blood; but, as he had used a copper vessel, he attributed to this the copper which he detected in the ashes.

In 1830, M. Sarzeau published, in the *Journal de Pharmacie*, a work on the presence of copper in vegetables and blood.

In this work the author, being desirous of giving every one his due, sets forth, according to Berzèlius, in his *Traité du Chalumeau*, published in 1821, page 7:—1st, that Gahn, long before it had been suspected that the ashes of vegetables contained copper, had several times extracted this metal from the ashes of different kinds of paper:—2nd, that Vauquelin, in analysing a plant, had found copper in it, in a more conclusive manner:—3rd, that the discovery of copper in vegetables, belongs to Meissuer, who detected it in a great number of exotic and indigenous plants. The following is the process which he adopted, and which is published in Schweigger, Vol. xvii. pp. 340 and 346. The plant is incinerated, and the ashes are washed with distilled water, to remove the soluble salts: the residue is boiled with hydro-chloric acid, the solution is saturated with ammonia, so as to leave only a slight excess of acid; it is filtered, and a plate of iron or zinc is steeped in the liquid, and assumes a cupreous appearance, at the expiration of a day or two.

According to these different experiments, M. Serzeau thus shows the quantities of the copper which he has obtained from the undermentioned substances:—

500 gr.	of grey quinquina yielded 2 milligr of Copper	
,, ,,	of Madder	2
,, ,,	of green Martinico Coffee	4
,, ,,	of yellow Bourbon Coffee	4
256 ,,	of Coffee grounds....	3
1½ kilog.	of Wheat incinerated	7
1½ ,,	of fine Flour........	1
1 ,,	of Blood taken cold..	1

M. Sarzeau also said that he found copper in bran, tea, rice, sarazin, rye, barley, corn, and in the bark of malambo. But, as he operated on too small quantities, he could not determine in what proportions.

This chemist concluded, from his experiments, that the annual consumption of flour in France represented 7,300,000,000 kilogrammes of wheat, containing 361,000,000 millogrammes of copper.

M. Sarzeau also says that bran contains a greater quantity of copper than wheat and flour; but he was unable to ascertain the wheat, on account of an accident which occurred during the operation.

M. S. has substituted another process for that of Meissner. It consists, 1st, in washing the ashes in water, in order to remove the soluble salts:—2nd, in treating with hydrochloric acid, in saturating the solution by an excess of ammonia, and in filtering the liquor:—3rd, in precipitating the copper by prussiate of potassa:—4th, in decomposing the prussiate thus obtained, by the action of heat, and in treating the residue by weak sulphuric acid, in order to convert it into a sulphate:—5th, in decomposing this sulphate by a piece of iron. He says that it is necessary to operate on one pound at least.

After giving the means by which he obtained these results, M. Sarzeau says positively:—

"Chemists, called upon to give an opinion in cases of poisoning, will thus find it necessary to be on their guard, when, in examining very large quantities of animal matter, they find only traces of copper: I say traces; for I do not think that there exists more than a milligramme of copper in a kilogramme of blood taken cold."

In 1832, Piétro Perréti, professor of Chemistry and Pharmacy at Rome, published a work on the presence of copper in wine. He gave means of detecting this metal, and distinguishing it when it exists in it naturally, and when it has been introduced into it. M. Sarzeau says that copper, or sulphate of copper which had been added to bread, may be detected by the blow-pipe, which is not the case with the copper which forms a constituent part of corn or flour.

In 1833, M. Boutigny published a work entitled: *On the presence of copper in corn and many other substances.* He sums up the results of his experiments as follows:—

1st, Food or broth prepared in copper vessels, almost always contains copper, more or less, which is a great objection to the uses of that metal for culinary purposes:

2nd, Wine, cider, and corn sometimes contain copper, but only when the ground in which the vines, apple-trees, and corn grow, contains it; which allows us to affirm that the presence of copper in vegetables, does not result from the act of vegetation, but from absorption.

3rd, The detection of copper in food and drinks, raises a medico-legal question, which causes a necessity for fresh investigations; and this should render juries very circumspect in cases of poisoning by copper.

In 1837, M. Bouchardat announced the presence of copper in muscles, and concludes by the following passage:—

"From these facts, it results that muscles may naturally contain a sufficient quantity of copper to produce poisoning.

"M. Bouchardat refers the presence of this copper to the muscles having been collected from the sheathing of ships. He says he obtained this metal by the process recommended by M. Sarzeau."

M. Bouchardat's opinion, which refers the poisonous action of muscles to the copper which they contain, has been contested by M. Orfila. The following is what he says on this subject:

"As to cupreous preparations, how can their introduction into the bodies of these molluscæ be conceived? Doubtless, after their solution in water, Now, the analysis of sea-water, made in various places, has never demonstrated the existence of an atom of copper; besides, would not these animals be killed by swallowing a cupreous preparation?"

From what we have above explained, it would seem that the existence of copper in the native state in various substances is well demonstrated: we also think that the recent publications of M. Orfila may permit greater rapidity of operation, by treating flour or bread with pure nitric acid, obtaining a *nitric carbon*, treating it with distilled water, filtering, passing a current of hydro-sulphuric acid through the filtered liquor, collecting the precipitate, converting it into a sulphate and using the sheet of iron. The carbon may be incinerated in order to ascertain whether any copper remains in it, which is not probable.

MR. SPENCER ON THE ELECTROTYPE.

(From the Athenæum.)

Sir.—I take this opportunity of laying before yourself and readers a brief detail of a still further improvement of my voltaic process, of multiplying works of art in metal. In my pamphlet, (printed last September), I stated that I considered the process comparatively incomplete, unless we were able to apply it to the multiplication of models in clay or wood, castings in plaster, wood engravings, &c., as the fact, that galvanic deposition always requires a metallic surface to act on, seemed to set bounds to these branches of its application. I then resorted to various expedients to surmount the difficulty,—among others, that of gilding and bronzing the surfaces of such materials to a limited extent; this was successful, but still troublesome and expensive, and, more than all, the sharpness and beauty of the original was necessarily injured. I have since attempted to metallize surfaces by the use of plumbago, (suggested to me many months ago by Mr. Parry, of Manchester). This last possesses some of the faults common to the others in a greater degree, and in some instances the deposition goes on partially.

I am happy, however, to inform you, I have now adopted a method which answers completely, obviating all these objections, and leaving the surface of the material to be acted on as sharp as it was previous to the operation.

Should I be desirous of obtaining a copper mould or cast from a piece of wood, plaster, or clay, or, indeed, any non-metallic material, I proceed as follows:—Suppose it is an engraved wooden block, and I am desirous of metallizing it, in order that I may be able to deposit copper on its surface, (this example will hold good for any other material,) the first operation is to take strong alcohol, in a corked glass vessel, and add to it a piece of phosphorus (a common phial corked will answer the purpose); the vessel must now be placed in hot water for a few minutes, and occasionally shaken. By this means the alcohol will take up about a 300th of its bulk of phosphorus, and we thus obtain what I would term an alcoholic solution of phosphorus. The next operation is to procure a *weak* solution of nitrate of silver, place it in a flat dish or a saucer; the engraved face of the block must now be dipped in this solution, and let remain for a few seconds, to allow capillary action to draw it into the wood.

This operation being performed, a small portion of the alcoholic solution of phosphorus must now be poured in a capsule or watch-glass, and this placed on a sand-bath, that it may be suffered to evaporate. The block must now be held with its surface over the vapour, and *an immediate* change takes place; the nitrate of silver becomes deoxidized, and gives place to a *metallic* phosphoret of silver, which allows the voltaic deposit to go on with as much rapidity and certainty as the purest silver or copper.

The whole process may be performed in a few minutes, and with absolute certainty of success. The interior or exterior surface of a plaster or clay mould of a statue, no matter what size, may be thus metallized with equal facility. For the process of vaporizing, and should the material to be acted on not be very large, I prefer fastening it to the top of a bell glass receiver with a bit of pitch or cement, and thus placing it *over* the capsule on the sand bath; the phosphoric vapour is by this means equally diffused, and not dissipated. An ethereal solution of phosphorus also answers; and a solution of either of the chlorides of gold or platinum may be used. I am inclined to think this process, independent of its uses in galvanic precipitation, may be applicable to other branches of art. I would recommend those curious of testing its effects, to try a small and sharp plaster of Paris medallion: dip its *surface* in a weak solution of nitrate of silver and *take it out immediately*, fasten it to the bottom of a glass tumbler, and at the same time have a little hot sand ready in a dish; lay the watch glass containing a few drops of the phosphoric solution on it; now place the mouth of the tumbler over all, and the medallion will be observed almost instantly to change color. The operation is now completed. A piece of pottery ware in the state of biscuit may be acted on in a similar manner.

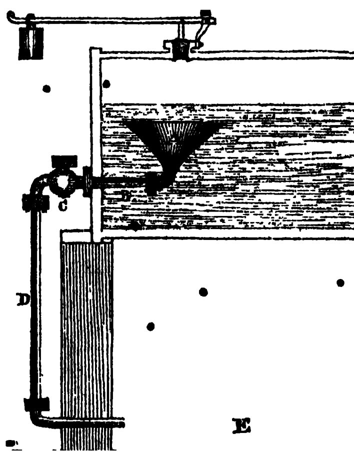
THOMAS SPENCER.

Liverpool, June 27.

A MUD APPARATUS FOR STEAM BOILERS.

To the Editor.

SIR.—The following apparatus has been successfully used with a steam boiler, which hitherto collected mud and other sediment from the water, so rapidly as to compel the proprietor to have it cleaned at least twice a year. This inconvenience suggested the following apparatus, which has been used for the last nine months with the greatest satisfaction to the inventor. A day or two back when the man-hole plate was removed, the boiler was found as perfectly clean and free from mud and all other kind of sediment, as when first put up.



A represents a hopper placed within the boiler about six inches below the surface of the water, which is shown in the above diagram by the dotted lines. B is an iron pipe screwed on the lower end of the hopper. C a cock which is likewise firmly screwed on the other end of the pipe, the cock having another pipe D, on its opposite end extending down to the ash-pit E.

When the water boils the mud is thrown upwards by the force of ebullition, and as it descends again by its own gravity a part of it is caught—according to the size of the hopper, viz:—if the hopper is 1-10th the size of the boiler, 1-10th of the mud will be caught and there remain, perfectly still and quiet till the cock C is turned, when the elastic force of the steam above, pressing on the contents of the hopper the whole will be discharged into the ash-pit—this ought to be done at least three times a day. HOMME.

Note.—The pipe used should not be less than an inch in the bore.

ASSAYING OF METALLIC ORES.

BEFORE metallic ores are worked upon in the large way, it will be necessary to inquire what sort of metal, and what portion of it, is to be found in a determined quantity of the ore; to discover whether it will be worth while to extract it largely, and in what manner the process is to be conducted, so as to answer that purpose. The knowledge requisite for this, is called the art of assaying.

Assay of Ores in the Dry Way.—The assaying of ores may be performed either in the dry or moist way; the first is the most ancient, and, in many respects, the most advantageous, and consequently still continues to be mostly used.

Assays are made either in crucibles with the blast of the bellows, or in tests under a muffle.

Assay Weights.—The assay weights are always imaginary, sometimes an ounce represents an hundred weight on the large scale, and is subdivided into the same number of parts, as that hundred weight is in the great; so that the contents of the ore obtained by the assay, shall accurately determine by such relative proportion, the quantity to be expected from any weight of the ore on a larger scale.

Roasting the Ore.—In the lotting of the ores, care should be taken to have small portions from different specimens, which should be pulverized, and well mixed in an iron or brass mortar. The proper quantity of the ore is now taken, and if it contain either sulphur or arsenic, it is put into a crucible or test, and exposed to a moderate degree of heat, till no vapour arises from it; to assist this volatilization, some add a small quantity of powdered charcoal.

Fluxes—To assist the fusion of the ores, and to convert the extraneous matters connected with them into scoria, assayers use different kinds of fluxes. The most usual and efficacious materials for the composition of these are, borax, tartar, nitre, sal-ammoniac, common salt, glass, fluor-spar, charcoal powder, pitch, lime, litharge, &c., in different proportions.

Crude of White Flux.—This consists of 1 part of nitre, and 2 of tartar, well mixed together.

Black Flux.—The above crude flux detonates by means of kindled charcoal, and if the detonation be effected in a mortar slightly covered, the smoke that rises unites with the alkalised nitre and the tartar, and renders it black.

Cornish Reducing Flux.

10 oz. of tartar,
3 oz. and 6 drachms of nitre, and
3 oz. and one drachm of borax.—Mixt well together.

Cornish Refining Flux.—Deflagrate, and afterwards pulverize, 2 parts of nitre, and 1 part of tartar.

The above fluxes answer the purpose very well, provided the ores be deprived of all their sulphur; or, if they contain much earthy matters, because, in the latter case, they unite with them, and convert them into a thin glass: but if any quantity of sulphur remain, these fluxes unite with it, and form a liver of sulphur, which has the power of destroying a portion of all the metals; consequently, the assay under such circumstances must be very inaccurate. The principal difficulty in assaying appears to be in the appropriation of the proper fluxes to each particular ore, and it likewise appears, that such a discriminating knowledge can only be acquired from an extensive practice, or from a knowledge of the chemical affinities and actions of different bodies upon each other.

In assaying, we are at liberty to use the most expensive materials to effect our purpose, hence, the use of different saline fluxes; but in the working at large, such expensive means cannot be applied; as by such processes the inferior metals would be too

much enhanced in value, especially in working very poor ores. In consequence of which, in smelting works, where the object is the production of metals in the great way, cheaper additions are used; such as lime-stone, feld-spar, fluor-spar, quartz, sand, slate, and slags. These are to be chosen according to the different views of the operator, and the nature of the ores. Thus iron ores, on account of the argillaceous earth they contain, require calcareous additions, and the copper ores, rather slags or vitrescent stones, than calcareous earth.

Humid Assay of Metallic Ores.—The mode of assaying ores for their particular metals by the dry way, is deficient so far as relates to pointing out the different substances connected with them, because they are always destroyed by the process for obtaining the assay metal. The assay by the moist way is more correct, because the different substances can be accurately ascertained. The late celebrated Bergman first communicated this method. It depends upon a knowledge of the chemical affinities of different bodies for each other; and must be varied according to the nature of the ore; it is very extensive in its application, and requires great patience and address in its execution. To describe the treatment of each variety of metallic ores, would take up too much of our room; but to give a general idea, we shall describe the procedure, both in the dry and the humid way, on one species of all the different ores.

To Assay Iron Ores. No. 1.—The ore must be roasted till the vapour ceases to arise. Take 2 assay quintals of it, and triturate them with one of fluor-spar, $\frac{3}{4}$ of a quintal of powdered charcoal, and 4 quintals of decrepitated sea salt; this mixture is to be put into a crucible, lined on the inside with clay and powdered charcoal; a cover must be luted upon the crucible, and the crucible itself exposed to a violent fire for an hour, and when it is cool, broken. When, if the operation has been well conducted, the iron well be found at the bottom of the crucible; to which must be added those metallic particles, which may adhere to the scoria. The metallic particles so adhering may be separated, by pulverizing it in paper, and then attracting them with a magnet.

No. 2.—If the ore should be in a calciform state, mixed with earths, the roasting of it previous to assaying, if not detrimental, is at least superfluous; if the earths should be of the argillaceous and siliceous kind, to half a quintal of them, add of dry quick lime and fluor-spar of each 1 quintal and $\frac{1}{2}$, reduced to powder, and mix them with $\frac{1}{4}$ of a quintal of powdered charcoal, covering the whole with one ounce of decrepitated common salt; and expose the luted crucible to a strong forge fire for an hour and a quarter, then let it gradually cool, and let the regulus be struck off and weighed.

No. 3.—If the ore contain calcareous earth, there will be no occasion to add quick lime; the proportion of the ingredients may be as follows:—viz. 1 assay quintal of the ore; 1 of decrepitated sea-salt; $\frac{1}{4}$ of powdered charcoal; and 1 of fluor-spar, and the process conducted as above.

There is a great difference in the reguli of iron; when the cold regulus is struck with a hammer and breaks, the iron is called cold short: if it break on being struck red-hot, it is called red short; but if it resist the hammer, both in its cold and ignited state, it is good iron.

Humid Assay of Iron Ore.—To assay the calciform ores, which do not contain much earthy or stony matter, they must be reduced to a fine powder, and dissolved in the marine acid, and precipitated by the Prussian alkali. A determinate quantity of the Prussian alkali must be tried previously, to ascertain the portion of iron which it will precipitate, and the estimate made accordingly. If the iron contain any considerable portion of zinc or manganese, the precipitate must be calcined to redness, and the calx treated with diluted nitrous acid, which will then take up only the oxide of zinc; when this is separated, the calx should again be treated either with nitrous acid, with the addition of sugar, or with the acetous acid, which will dissolve the manganese, if any; the remaining oxide of iron may then be dissolved by the marine acid, and precipitated by the mineral alkali; or it may be farther calcined, and then weighed.

Zinc Ores.—Take the assay weight of roasted ore, and mix it well with $\frac{1}{8}$ part of charcoal dust, put it into a strong luted earthen retort, to which must be fitted a receiver; place the retort in a furnace, and raise the fire, and continue it in a violent heat for two hours, suffer it then to cool gradually, and the zinc will be found adhering to the neck of the retort in its metallic form.

In the humid way.—Distil vitriolic acid over calamine to dryness; the residuum must be lixiviated in hot water; what remains undissolved is siliceous earth; to the solution add caustic volatile alkali, which precipitates the iron and argil, but keeps the zinc in solution. The precipitate must be re-dissolved in vitriolic acid, and the iron and argil separated.

Tin Ores.—Mix a quintal of tin ore, previously washed, pulverized, and roasted, till no arsenical vapour arises, with half a quintal of calcined borax, and the same quantity of pulverized pitch; these are to be put into a crucible moistened with charcoal-dust and water, and the crucible placed in an air furnace. After the pitch is burnt, give a violent heat for a quarter of an hour, and on withdrawing the crucible, the regulus will be found at the bottom. If the ore be not well washed from earthy matters, a large quantity of borax will be requisite, with some powdered glass; and if the ore contain iron, some alkaline salt may be added.

In the humid way.—The assay of tin ores in the liquid way, was looked upon as impracticable, till Bergman devised the following method, which is generally successful. Let the tin ore be well separated from its stony matrix, by well washing, and then reduced to the most subtle powder; digest it in concentrated oil of vitriol, in a strong heat for several hours, then, when cooled, add a small portion of concentrated marine acid, and suffer it to stand for an hour or two; then add water, and when the solution is clear, pour it off, and precipitate it by fixed alkali—131 grains of this precipitate, well washed and dried, are equivalent to 100 of tin in its reguline state, if the precipitate consist of pure tin; but if it contain copper or iron, it must be calcined in a red heat for an hour, and then digested in nitrous acid, which will take up the copper; and afterwards in marine acid, which will separate the iron.

NOTE.—The names of the acids &c. in this paper, are purposely given as known to the Miner rather than the Chemist.

(To be continued.)

COLORING INSECTS.

BY M. J. J. VIREY.

Before the discovery of the Mexican cochineal *(coccus cacti coccinelliferi)*, the ancients know how to obtain a purple dye, not only from the univalve shell-fish, called murex, but also from several insects. A purple dye is spoken of in the Bible; and every thing tends to convince us that it was not extracted (at least not entirely) from the kermes, or *coccus ilicis*, but from a cochineal procured from Armenia and Persia, formerly known to travellers and merchants by the name of *tschrew*. This term signifies a little red worm, like our word vermillion, and like the word scarlet (or *scharlath* of the Germans) comes from *kermesinas*, &c.

This cochineal was not well known to naturalists, until the publication of the recent Memoir of M. Brandt. It abounds in Erivan, and the valleys of Ararat; parts of Persia and Armenia, now incorporated with the empire of Russia. It is particularly common in the swampy meadows surrounding Araxis, and fixes on the root of the *Poa Pungens*, or the *Oeluropus Lævis* of Trinius.

It is evident, therefore, that its habits resemble those of the *Coccus Polonicus*, described by Breyn, which grows on the *scleranthus perennis:* but the Armenian cochineal is much thicker than the Polish: it requires but from 18 to 23 thousand individuals to weigh 360 grammes, or a pound (of 12 ounces), whilst it requires 100, and sometimes 130 thousand of the *Coccus Polonicus*, for the same weight. Mexican cochineal runs 20 to 25 thousand to the pound: therefore it presents scarcely as much coloring matter as the Armenian; but the Polish gives the least (it is the *Porphyrophora Frischii.*)

According to Brandt, Armenian cochineal *(porphyroph. Hamelii)* is distinguished by thirteen or fourteen articulations to each antenna, in the male, and a brush of the hair at the anus. The female, in the state of larva, lives in a shell attached to the root of the plant: it can dig the ground with its fore paws. When perfect, the mouth is entirely obturated, as in the Polish kermes; for these animals are of the same genus, although they are of different species.

We may also mention, among tinctorial insects, the *trombidium tinctorium* Fahr. (*acarus tinct.* of Linnæus), which is common in hot climates, as in Senegal and Sennaar, according to Caillaud, and particularly in Guinea, where it has begun to be made use of in dyeing.

The Carapathos, very small red acarus, like our roach, are immensely numerous in the woods and thickets of Brazil, Paraguay, and French Guiana, and a beautiful color might also be extracted from it, were it not for the insupportable itching which they occasion on the skin. However, the vapour of vinegar causes them to perish easily.

The beautiful butterflies, or the coleoptera which it is desired to preserve uninjured for collections, may be killed by putting a drop of acetate of strychnia in either the trunk or the mouth. The insect falls motionless without spoiling its shape. The inhabitants of Santa Fé hunt these insects to eat them. They make omelettes of them, or, after having fried them, they cover them with sugar, to make comfits of them.—*Chemist.*

PREPARATION OF PURE TELLURIAN.

BY BERZELIUS.

Telluret of silver has lately been found in Siberia, and telluret of bismuth at Schemnitz. Berzelius has obtained the metal in a pure state from the former by the following process:—Mix dry carbonate of potash intimately with the well-pulverized mineral, make it into a thick paste with olive oil, and put it into a porcelain crucible with a cover. The crucible is then to be at first gently heated, till the oil is carbonized; and when gas ceases to burn at the edges of the crucible, the heat is to be raised for a moment to whiteness, and the crucible then allowed to cool. A deep, brown, porous mass is obtained; it is to be quickly powdered in a dry mortar, and thrown upon a dry filter and washed with boiling distilled water, with as little contact of air as possible.

A liquor of a rich red color is obtained, which whenever it comes in contact with the air, becomes of the lustre of silver from the tellurium which separates, while the potassium oxidizes by the oxygen of the air. As soon as the liquor passes colorless, the mass on the filter is sufficiently washed, and is composed of charcoal and bismuth, containing mere traces of tellurium.

The deep red solution contains telluret of potassium mixed with more or less sulphuret and seleniuret of potassium, with a small quantity of telluret of gold, copper, manganese, and iron. If the solution be suffered to remain at rest, the surface becomes covered with a pellicle of tellurium, and gradually, but very slowly, it becomes turbid to the bottom: by blowing air into it the mass oxidizes readily. The potassium becomes potash, and the tellurium is precipitated by oxygen. When the precipitation has ceased, the solution assumes a green color, and if it be poured off at this moment, it deposits in a few seconds a very small quantity of tellurium, and the liquor becomes yellow when the precipitation has ceased. The green color is owing to a mixture of the blue tint occasioned by the small quantity of tellurium mixing with the yellow color of the liquor. Sometimes the remaining liquor is of a dull rose color, and gives no precipitate in several days; this is owing to the telluret of iron which it contains.

As long as the potash is in access, the sulphur and the selenium are not precipitated, but the access of air converts them into acids; this is a method of obtaining tellurium free from these substances. Muriatic acid precipitates from the yellow solution the selenium and the sulphuret of tellurium which it contains, in the state of sulphuret and seleniuret of tellurium.

The tellurium precipitated from the alkaline solution is a very fine and dense powder: it must be purified by distillation; but on account of its slight volatility it cannot be sublimed from a retort in a common furnace. In order to effect it, a long porcelain vessel, containing tellurium, was put into a large porcelain tube in a furnace; it was heated to redness, and a current of hydrogen gas passed over it. The tellurium was converted into vapour, and it was constantly carried by the hydrogen towards the cold parts of the tube, where it was condensed. In order to make the tellurium flow after its condensation, the tube must be slightly inclined. In a short time all the tellurium distils, and there remains in the porcelain vessel a small button formed

of the tellurets of gold, copper, and iron; the product of the distillation is pure tellurium.

In general the process, which consists in fusion with potash and charcoal, may be employed to purify tellurium, especially if it contains sulphur, selenium, or arsenic, all bodies which cannot be separated from it by distillation. The arsenic goes off in vapour at a red heat, and the two others, after the precipitation of the tellurium by the air, remain dissolved in the liquor. The solution of potash contains the metals which render the tellurium impure. If in this operation powdered charcoal be employed instead of oil, the mixture may be strongly heated at once, but the solution of telluret of calcium; and as the lime which is produced is precipitated with the metal, the precipitate must be first washed with muriatic acid, and then with water. The quantity of charcoal ought always to be sufficient to prevent the mass from fusing during reduction, for then it would go over the edges of the crucible and part of it would be lost.

ON THE COLORS OF FLAME.

To the Editor.

SIR.—Allow me to offer a few remarks concerning the color of the flame of a candle, in refutation of an article of one of your correspondents, which appeared in No. 63. His theory is certainly altogether new, and I may say somewhat obscure, in consequence of making carbon the *only* matter cooled during combustion; tallow, wax, oil, and most of the oleaginous combustible bodies, being composed of carbon and hydrogen, with a small portion of oxygen; when the candle is lighted, the two former are given off in the form of carburetted hydrogen gas, and is precisely the same in its composition as coal and oil gas; so that the flame of the candle is caused by the ignition of this gas, and not of carbon alone. If "the carbon at the lower part of the flame were *effectually* burned," the temperature at that part should be greater than in the higher portion, where it is "not completely burned," whereas the contrary is the case; and as regards the "unburned vapour of carbon" in the interior of the flame, it is well known to chemists that it is capable of existing in the form of vapour, even with the greatest heat we can produce, unless combined with some other gas; so that the very proposition, being false, the argument falls to the ground. Taking then as an established fact, that the flame of a candle is nothing more than carburetted hydrogen gas in a state of combustion, we can easily account for the various colored parts of the flame. When a candle is first lit, the wick alone is consumed until the flame approaches sufficiently near to melt the candle; the grease is then drawn into the body of the flame by the capillary attraction of the wick, and is there decomposed by ignition, and is given off in the form of carburetted hydrogen, and this coming in contact with the atmosphere during combustion, is again decomposed by the oxygen uniting with its carbon and hydrogen, forming carbonic acid and water. The higher the temperature of flame, the greater is its brilliancy, consequently, the lower part being constantly supplied with a current of cool air, its temperature is diminished and the flame becomes blue at that part, while the air which abstracted the heat ascends, and preserves a warm atmosphere around the upper portion. To prove this, Professor Donovon, of the Royal Irish Academy, constructed a cylinder of ice open at both ends, and inclosed in it a jet of coal gas, when the flame almost constantly became blue, and after some time went out. Again, if we put a wire in the white part it becomes red hot, but if we pass it into the blue portion it is instantly cooled. In a jet of coal gas we observe a larger portion of the blue color, than in the flame of a candle, on account of the metal being so much better a conductor than the wick; but if the metal be heated to whiteness, or a taper held immediately below the flame, the blue color disappears. This blue color, however, is not confined alone to the lower part; for, if we hold some object between the eye and the flame, so as to exclude the dazzling light, we shall observe a faint rim of blue encircling the upper portion as well, which constitutes the extreme edge of the flame, being in immediate contact with the air. Flame is nothing but a hollow cone, whose surface is the ignited film, which is supplied with gas from its reservoir in the dark central portion; for if a small tube be inserted therein, it may be either drawn off and collected, or it may be ignited at the extremity. That there exists a very low temperature in the centre of the flame, is evident from the deposition of carbon which takes place on the wick, which being a non-conductor of heat, maintains a lower temperature than the vapour which surrounds it; when the wick reaches the ignited portion of the flame, it abstracts a portion of the heat in order to be consumed; it is, consequently, incapable of consuming so much grease as before; the superabundance therefore overflows, and runs down the side of the candle, the combustion is imperfect, a portion of the carbon is carried off unconsumed in the form of smoke, the candle gives less light, and requires snuffing in order to get rid of the obstruction. The well known experiment of blowing out a candle and relighting it from the smoke, results from the stream of carburetted hydrogen gas which issues from the wick. When a cold metallic plate is thrust in the centre of a flame, the carbon of the gas is condensed before it comes in contact with the atmosphere; but if the candle be held directly above the flame, no carbon is condensed, as carbonic acid, and water alone comes in contact with the plate. The cause then of the various colored parts of flame may be stated as follows:—The lower part and edge of the flame are blue, in consequence of being subjected to a lower temperature than the rest; the interior being hollow where no flame exists appears darker; while the other portion, being in a complete state of ignition, appears the brightest.

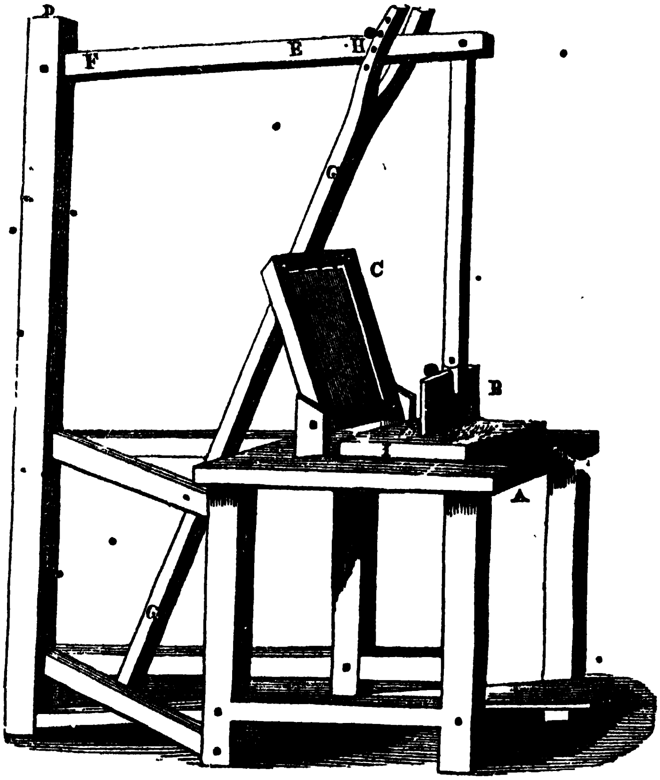
J. COOKE.

MISCELLANIES.

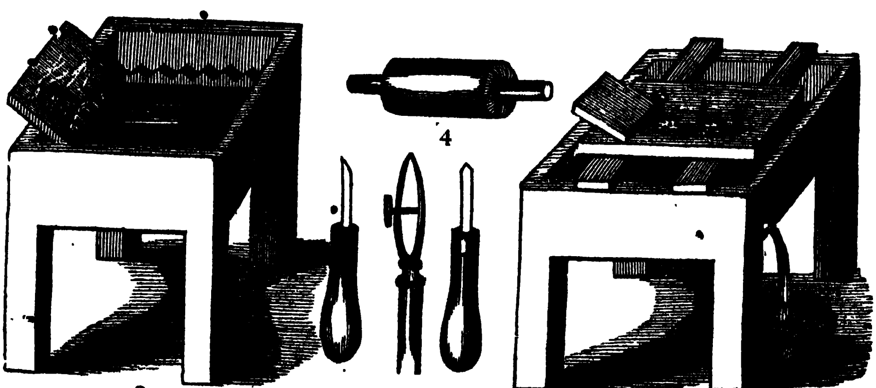
Gas from Grapes.—An interesting experiment has been made at Bourdeaux, on the husks of grapes, when pressed, and the lees of the wine, in order to show their use for the purposes of lighting. A pound of the dried husks put into a red-hot retort, gave, in seven minutes, 200 litres of gas, which burnt with an intense light, and free from smoke or smell. A second experiment with the dried lees was equally satisfactory.

The Mulberry.—M. Seringe argues from physiological facts, that pruning the mulberry at the same time that the leaves are gathered, will produce a handsomer and a longer-lived tree, and a greater abundance of leaves.

Fig. 1.



APPARATUS FOR LITHOGRAPHIC PRINTING.



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3. 7. 5. 6. 2.

LITHOGRAPHY.

(Resumed from page 110.)

We have in the former papers upon this subject given an account of the stones and various preparations used in this art; at the present time we shall confine our attention entirely to describe the apparatus necessary—with one of the simpler presses, leaving, till a future opportunity the directions necessary in the drawing and printing, as well as on other matters connected with the subject.

Fig. 1 is the *Lever Press.*—An instrument, cheap, easy to manufacture, expeditious in working, and adapted particularly to cards, small circulars, &c.—for larger work the pressure is not sufficient.

A, represents a common strong table, having framed to its hinder legs, bars to support the upright post D—this table supports the stone I. C is a square frame covered with leather, exactly like a printer's tympan is with parchment; this is large enough to cover the stone, and is capable of being thrown back or brought down upon the stone, by the hinges or pivots which connect it with the table—it is usually supported on its pivots at such a height as to fall flat down upon rather a thin stone. The upright D should be as long as possible, as the longer it is, the more equably the scraper works on the stone. The cross bar E is of course capable of an up and down motion, and its height, and consequently the height of the scraper B, which is attached to it, is regulated by an iron pin put through one or other of the holes H, at the upper part of G G.

B, the scraper, is made to have a swinging motion backwards and forwards in the socket at the top, where it is connected with E. The scraper itself is formed of box wood or hard mahogany, and fits into a joint cut to receive it—it is fastened by a pin or screw, only sufficiently tight to keep it steady, being allowed nevertheless a little play sideways, in order to accommodate itself to the stone; if this latter should be higher on one side than the other—thus by means of these various adjustments, the scraper can be moved readily in every direction. The lower end of G is fixed by a moveable joint into the treadle beneath. By bearing on the treadle, the scraper is forcibly pressed upon the stone and worked with the hand, by pulling it backwards and forwards. It should be mentioned that the pole which supports the scraper, should be made of two parts jointed to each other, so that when the printer draws the scraper to him, the whole shall form one straight line, and when he pushes it away, it bends back. In all presses the leather must be stretched tight and well greased at the back, to enable the scraper to slide with ease.

Fig. 2.—*The Table for rubbing down the Stones.*—This table is open at the top, and has two cross-bars to lay the stones on. The bottom of the table slopes towards the hole, in order to let the sand and water run out in a tub placed underneath for that purpose; the sand which falls in this tub may be dried, and when sifted, serves for fine graining the stones.

Fig. 3.—*Etching Box.*—This box may be made of any size; it must be water-tight, and have two pieces of wood with notches fixed in its bottom. The stone, when it is being etched, must rest on the notches and pieces of wood.

Fig. 4.—*Roller for Charging the Drawings with Printing Ink.*—These rollers may be made of any length, but must not be less than four inches in diameter. They are made of alder or lime-tree; the wooden handles which project serve for the printer to hold them by: the rollers must be turned with great care, and covered with at least three complete turns of flannel, well stretched and nailed at the extremity of the rollers, near the handles; the whole is covered with a calf's-skin, sewed with great care, and so as to fit tightly. This operation is performed as follows:—the calf's-skin is wetted, stretched on a board with nails, and allowed to dry; it is then cut so as to fit the roller well; the seam must be sewed with silk, and with what shoemakers call a closing-stitch; this must not be performed on the roller, but separately, and with the smooth side outwards; when the seam is finished the skin must be turned with the rough side outwards, and is then slipped on the roller like a glove: the extremities (the skin being cut longer than the roller) must be tied together with a string or nailed on.

As in turning the rollers on the stone the handles might hurt the printer's hands, two little handles are employed, and so made that on their being pushed more or less on the wooden handles, they work more or less easily; this effect may also be greatly helped by the pressure of the hands.

This mode of holding the rollers is a most important thing in lithography, and a lithographic printer ought to study it with the greatest care: if he perfectly understands how to manage the roller, he may either force the stone to receive more ink, or take it up from the stone; in short, he may vary as he likes the effect of the prints, and even change the entire tint of the impressions.

As the stones for ink drawings are polished, it is not so easy to make the rollers turn on them; in which case wooden handles are substituted for the leather ones.

In passing the roller, which is besmeared with printing ink, over the stone, those parts which have been previously wetted will of course refuse to receive it, while, on the contrary, the greasy lines will attract it, according to the intensity with which they are drawn, and the difference which exists between the several tints will depend entirely on the varied effects of the drawing, and on the manner in which the printer will press with his roller.

In order to prepare a roller for receiving the printing ink, it must be held near the fire and well besmeared with lard, which must afterwards be scraped off; it must then be worked for two or three days on the table with printing ink, and is then fit for use.

If a roller is to be laid by for more than a fortnight, the ink must be with care scraped off, and it must be besmeared with hog's lard.

Fig. 5 is a *Steel Pen* with a screw for drawing straight lines: this is an indispensable instrument for drawing lines: the sides must be much more bent than those usually found at instrument makers: this is done in order to enable the ink to flow freely to the point, which otherwise it would not do. As the points of this instrument soon get blunt by use, the moment that is the case, they must be ground with great care on a hone with oil. This is a very delicate operation, as the fineness of the lines depends entirely on the points being perfectly sharp and even.

Quills and pens are very soon blunted by the nature of the stone and of the ink; steel pens are the only ones that can be used. These are made out of a very thin piece of steel, which must be bent in the form of half a cylinder; cut with a pair of

sharp scissors, tempered, and then ground on a hone; these pens are fixed on a common quill.

A miniature hair pencil is also an indispensable article; two-thirds of the hair must be cut off with a sharp penknife, so that only twelve or fourteein hairs remain. A hair pencil thus prepared, and the steel pen, are the only instruments with which drawings can be executed that can equal engravings in the delicacy of the lines.

The common scrapers for scratching out writing are not convenient for lithography; it is better to take pieces of square steel, shaped as represented in Figs. 6 and 7, ground on a stone, and fixed in handles.

(To be continued.)

ON THE NEW METAL LATINIUM.

BY JAMES C. BOOTH AND CAMPBELL MORFIT.

The name is derived from the Greek λανταvειν to lie hid; * it is called in Swedish and German Lantan, but in English Latanium, for the sake of euphony and in accordance with the generally recived termination of the names of the elements. The ordinary method of obtaining cerium by precipitation with the bisulphate of potassa, threw down a bisalt of Latanium at the same time, the latter constituting two-fifths of the whole saline mass. The method of separating the two depends on the ready solubility of oxide of latanium in dilute acid after ignition, a property lost by cerium under the same circumstances. From its nitric solution, it may be best thrown down as a white, crystalline carbonate, by carbonate of ammonia, and from this its other compounds may be formed. The dry chloride heated with potassium was reduced to grey metallic powder possessing a dark lead color, and capable of being flattened together by pressing. It is slowly converted into oxide in the air, and in cold water into a hydrated oxide with the evolution of hydrogen. An effervescence takes place in hot water.

It has two isomeric states. The ordinary salts possess a faint reddish tinge, but when the yellowish red oxide is heated in hydrogen gas, it becomes white with a faint shade of green, and dissolves with more difficulty in acids, forming salts which possess a greenish hue.

With bisulphate of potassa it forms a slowly soluble salt, which however, does not precipitate like the corresponding salt of cerium, unless the latter be also present in the solution. Its atomic weight is lower than that adopted for the oxide of cerium.

The above notice is mainly extracted from Berzelius' letter to Poggendorff, published in Nos. 4 and 5 of Poggend. Annals for the present year. Our experiments were as follows:

Having prepared the sulphate of cerium and potassa by the ordinary methods from the mineral cerite, it was dissolved in a large quantity of boiling water and the hydrated oxides of cerium and latanium precipitated by caustic potassa. These were dissolved in nitric acid after being thoroughly washed, evaporated to dryness, and heated in a platinum crucible until all the nitric acid was expelled. The oxides remained of a light reddish brown color, and were transferred to a gloss containing nitric acid diluted with 60 to 80 times as much water. After digesting about two hours in a gentle warmth, the latanium is dissolved and oxide of cerium remained of a reddish-brown color. The solution treated with caustic potassa threw down the white hydrated oxide latanium, much more bulky and gelatinous in appearance than alumna. It is exceedingly difficult, if not impossible, to wash it out throughly, for after edulcoration for several days, the liquid passing through the filter still gave indications of a solid matter, and almost led to the belief that the oxide was slightly soluble in water.

On re-dissolving hydrated oxide in nitric acid, evaporating to dryness, and heating to redness the dry oxide remained of a brick-red color, differing therefore from the oxide of cerium by a lighter hue, and by containing less of brownish shade. On treating this oxide as before with very dilute nitric acid, a small portion of oxide of cerium remained, proving that this mode of separating the two metals is not accurate, and that we must await further experiments for the discovery of a more perfect method.

Carbonate of latanium, as thrown down by carbonate of soda, is a voluminous white precipitate, and, like the hydrated oxide, very difficult of edulcoration, for after obtaining the chloride from it, crystals of common salt were also visible. Agreeable to the observations of Mosander, therefore, the carbonate of ammonia is the best precipitant.

Sulphate of latanium, as readily formed by the solution of the oxide, or carbonate, in dilute sulphuric acid, evaporation to a small bulk by heat and exposure to self-evaporation, while delicate needles of a flesh-red color collect in little groups on the bottom of the capsule.

The chloride is similarly formed by means of chloro-hydric acid and evaporation. It forms a light yellowish green crystalline mass, in which no determinate form was observed.

The quantity of latanium in our possession was so small, amounting only to a few grains, that the operations were necessarily conducted slowly and prevented our pursuing them quantitatively. Should we be enabled to obtain a larger amount, we may give more interesting results, without, however, trespassing on the field legitimatly belonging to the discoverer.—*Franklin Institute.*

* From its concealment hitherto in the compound of cerium.

INDIAN MODE OF PREPARING THE PERFUMED OILS OF JASMINE AND BELA.

Dr. Jackson of Ghazeepore, in a letter to the editor of the Asiatic Journal of Calcutta for June 1839, says;—In my last communication on the subject of rose-water, I informed you that the natives here were in the habit of extracting the scent from some of the highly-smelling flowers, such as the jasmine, &c., and that I would procure you a sample, and give you some account of the manner in which it is obtained. By the present steamer, I have dispatched two small phials, containing some of the oil procured from Jasmine and the Bela flower. Eor this purpose the natives never make use of distillation, but extract the essence by causing it to be absorbed by some of the purest oleaginous seeds, and then expressing these in a common mill. when the oil given out has all the scent of the flower which has been made use of. The plan adopted is to place on the ground a layer of the flower, about four inches thick and two feet squar over this they put some of the Tel or Sesamum seed

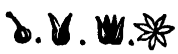
wetted, about two inches thick and two feet square; on this again is placed another layer of flowers, about four inches thick, as in the first instance; the whole is then covered with a sheet, which is held down by weights at the ends and sides. In this state it is allowed to remain from twelve to eighteen hours; after this the flowers are removed, and other layers placed in the same way; this also is a third time repeated, if it is desired to have the scent very strong. After the last process, the seeds are taken in their swollen state and placed in a mill; the oil is then expressed, and possesses most fully the scent of the flower. The oil is kept in prepared skins, called dubbers, and is sold at so much per seer. The Jasmine and Bela (Jasminum zamba) are the two flowers from which the natives in this district chiefly produce their scented oil; the Chumbul (Jasminum grandiflorum) is another, but I have been unable to procure any of this. The season for manufacture is coming on. The present oils were manufactured a year ago, and do not possess the powerful scent of that which has been recently prepared. Distillation is never made use of for this purpose, as it is with the roses, for the extreme heat (from its being in the middle of the rains when the trees come into flower) would most likely carry off all the scent. The Jasmine, or *Chymbele*, as it is called, is used very largely amongst the women, the hair of the head and the body being daily smeared with some of it. The specimen I send you costs at the rate of two rupees per seer.

ILLUSTRATIONS OF BOTANY.

(Resumed from page 109.)

Class VII.—Heptandria. Four orders.

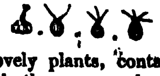
Plants with 7 stamens, and 1, 2, 3, 4, or 7 styles.



The noble Æsculus or Horse-chesnut belongs to this small class, which contains but one British plant, the Trientalis or Winter Green. The beautiful Calla Ethiopica here finds a situation, as well as its congeners, the lurid and mottled Dragons. Beyond these there are no plants of either beauty or interest, except indeed the neat little white-flowered Septas from the Cape of Good Hope, which has its calyx of seven sepals, its corolla of seven petals, seven stamens, seven pistils, and seven capsules.

Class VIII.—Octandria. Four orders.

Plants with 8 stamens, and 1, 2, 3, or 4 styles.



A class of lovely plants, containing the elegant Heaths, of which there are perhaps three hundred species, most of them natives of the Cape of Good Hope. The annual, commonly called Nasturtium, but properly Tropæolum or Indian Cress, is here too; and so are also the splendid Fuschia, the sweet-smelling Evening Primrose, the Whortleberries and the Cranberries, the Mezereon, and the Lace-bark tree, so called from its being formed in layers, that when separated exactly resemble lace, and is used as such by the natives of tropical islands, are all of order Monogynia. The plants of interest in the other orders are Persicaria and the Soap Berry in the third, and the four-leaved Paris in the last order.

Class IX.—Enneandria. Three orders.

Plants with 9 stamens, and 1, 3, or 6 styles.

As in class Heptandria, there is here but one plant of native growth, though one of considerable beauty, the Butomus or Flowering Rush, common enough on the banks of the Thames around London. Of foreign plants, the Cashew Nut and the family of the Laurels, as it contains the Sassafras, the Cinnamon, and the Camphor Tree, as well as those which produce the Gum Benzoin and the Alligator Pear, must be considered valuable, so also the Rhubarb which is placed in this class. The Butomus belongs to order Hexagynia.

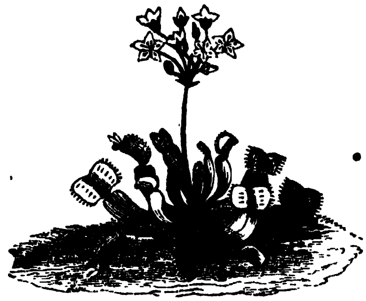
Class X.—Decandria. Five orders.

Plants with 10 stamens, and 1, 2, 3, 5, or 10 styles.

So common is it for plants to have their various parts arranged in fives or tens, that these classes are extremely extensive; the present, for example, contains perhaps 1000 species of plants, which are somewhat varied in character, most of them pretty; few of them splendid and majestic in port. Here are very numerous papilionaceous plants, a circumstance necessary to be remarked on account of the class Diadelphia, which consists wholly of these. Independent of the leguminous or papilionaceous plants of Decandria, there are some of general interest and favorite culture—the Pink, and its varieties the Carnation and Picotee, will always be admired; so will the Rhododendrons, the Kalmias, the Azalea, and the Arbutus; the Catchfly, the Chickweed, the Lychnis, the Corn Cockle, the Stonecrop in its many species, the Oxalis, and the pretty moss-like Saxifrages; nor is it easy to despise the noble Mahogany, the Logwood, the Brazil Wood, and the Lignum Vitæ tree.

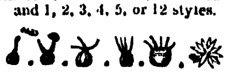
To the first order we must refer that greatest of all vegetable curiosities, the Dionæa Muscipula, or Venus Fly-trap, which catches the insects that settle upon it. In the swamps of Carolina it is abundant. Here, though not capable of living in the

open air, it is of easy culture in the hot-house, for which purpose seeds are annually imported.



Class XI —Dodecandria. Six orders.

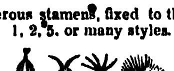
Plants with from 12 to 20 stamens, seated on the receptacle, and 1, 2, 3, 4, 5, or 12 styles.



A small class, but one containing some general favorites, among which is the lovely and fragrant Mignionette, (Reseda odorata.) In the same genus is also the Weld or Dyer's Weed, a yellow dye of considerable beauty, and which decorates most of our chalk pits and old walls. The Asarum Asarabacca is here placed, so also that ornament of our river banks, the Lythrum or purple Loosestrife; the Agrimony, and the well-known House-leek, the latter a plant which is remarkable in the regularity of its various parts, having twelve petals, twelve stamens, and twelve styles.

Class XII.—Icosandria. Three orders.

Plants with numerous stamens, fixed to the calyx, and with 1, 2, 5, or many styles.



The position of the stamens in this, and the classes next before, and after, must be carefully observed. Here they are always fixed to the calyx—in the others to the receptacle. This class contains no poisonous plant, the others have many, which are so. Here belong most of our fruit trees—the Apple, Pear, Plum, Cherry, Medlar, Peach, Apricot, Nectarine, Almond, Pomegranate, and Quince. Not merely these, but other plants of equal interest, the Allspice, the Pimento, the Clove, the Strawberry, the Myrtle, the Raspberry and Blackberry, (both of which are species of the Bramble.) The "Queen of Flowers," the Rose, also here holds dominion, as well as those beautiful families, the Cactus and the Mesembryanthemum—one species of which latter is so well known as the Ice plant.

The family of the Cactus bear flowers of the greatest splendour; leaves they have none; stems of the most distorted and extraordinary forms; and roots so penetrating, that they insinuate themselves into the interstices of the naked rock, where the plants grow in luxuriance, though apparently without support. The Cactus speciosissimus grows well with ordinary attention, and is a frequent ornament of our drawing-rooms—though the emblem of short-lived beauty, never lasting more than a day, and often but six or eight hours. The Cactus grandiflorus, or Night-flowering Cereus, bears a flower nearly a foot in diameter, of the most beautifully blended white and yellow, and of delicious fragrance. It expands about eight in the evening—is withered and decayed in six hours afterwards.

Class XIII.—Polyandria.

Stamens numerous, and fixed to the receptacle, therefore under the fruit.

The plants of this character are not always poisonous, but are yet to be viewed with suspicion. The Poppy, from whose juice we procure the deadly laudanum, belongs to Polyandria; and also the well-known and numerous family of the Buttercups or Ranunculus. The species cultivated with such care, the Ranunculus asiaticus, is found of every color whatever, except blue. The Anemone is another favorite. The Water Lily who shall praise too highly. The Columbine too, that emblem of folly—the splendid ornament of the American forest, the Magnolia — the pretty little Larkspur, the orange-juiced Celandine, the Traveller's Joy or Clematis, so sweet and with such feathery seeds—the Tea, and the Camellia, are all belonging to the class Icosandria. Searching more narrowly, we find also the Caper bush, the Lime tree, the elegant, but short-lived, Cistus, the magnificent Peony, the Tulip tree, and that celebrated and common tropical fruit, the Sour Sop or Custard Apple. The whole of the classes, perhaps, does not contain a more splendid collection of plants than are here included.

(To be continued.)

ETCHING UPON GLASS.

In the middle of the sixteenth century, when glasses manufactured in the Venetian states enjoyed the highest reputation throughout Europe, it was common to find those ornamented by engravings executed with the diamond. More than an hundred years had elapsed from that period, when Henry Schwanhard, a pupil of Lehmann, was incited by the accidental circumstance of the corrosion of his spectacle glass, to a method of etching on glass by means of some powerful acid liquor. His manner of preparing this liquor was kept secret by him; and as no fluid, save fluoric acid, with which we are acquainted, has the property of acting upon the surface of glass, while the discovery of this powerful menstruum was not brought before the world prior to the publication of Scheele's experiments in 1771, it is much to be regretted that the secret of Schwanhard was suffered to go with him to the grave.

The method pursued by this artist in the application of his discovery was different to that which

is practised at present. This is to coat over the entire surface of the glass with varnish, and, through this coating, to trace out the intended figures, leaving the glass exposed to the action of the acid only in those parts which are to be occupied by the figures. Schwanhard, on the contrary, first traced the figures, and, having filled the outlines on the glass with varnish, applied his corrosive fluid to the remainder of the surface. By this means the figures were left in relief, and with their original polish, the effect of which was pleasing, and totally dissimilar to the appearance of engravings with the diamond, which latter circumstance it probably was that incited the artist to the adoption of his peculiar method, since his productions would, by that means, be more readily distinguished from the works of others.

The varnish employed by artists for defending, where it is requisite, the surface of the glass from the corroding power of the acid, is usually either a solution of isinglass in water, or common turpentine varnish mixed with a small proportion of white lead.

By the aid of a very few implements, the art of etching on glass may be rendered a pleasing occupation for amateurs. Good crown-glass is the most proper description to be chosen for this purpose. Having selected a square pane of the proper size, this should be first heated by immersion in a sand-bath, and then rubbed over with purified bees'-wax, the temperature of the glass being such as to cause the wax to melt completely and uniformly over its surface. The pane, thus covered, must then be set aside to cool; and it is important to observe, that every part of its face must be protected by this coating of wax; which, however, need not be thick, and indeed should not be applied in sufficient quantity to render the glass opaque.

A paper having the design boldly drawn upon it, may then be attached to the unwaxed under-side of the glass; and this drawing will greatly assist the artist in performing the next process, that of tracing the design through the wax. The best kind of tool for executing this operation is a carpenter's brad-awl, which, as it is flattened at the end in one direction, and rounded in another, may, according to the position wherein it is held, be easily made to trace lines having the requisite and different degrees of fineness. The point of a pen-knife, or any similar implement, may be used as a substitute for the brad-awl, and with almost equal efficacy. In tracing these lines, the artist must be mindful that his instrument lays bare the surface of the glass throughout the whole extent of the strokes.

A shallow evaporating basin of Wedgewood ware must next be employed. Its size should be such as will include within its area every part of the design; and it must at the same time be sufficiently small to be completely covered when the pane of glass is made to rest upon its edge. Some coarsely powdered fluor spar must then be placed in the basin, together with a quantity of strong sulphuric acid, sufficient to form with it a thin paste, when the two substances must be well mixed together by stirring them. The quantity of fluor spar must of course be regulated by the size of the etching; and it may be a sufficient guide on that head, to recommend that two ounces of the coarse powder be used when the basin is capable of containing a pint: these basins are readily procurable from any respectable dealer in earthenware.

As soon as the acid and fluor spar are properly incorporated together, the pane of glass should be placed upon the basin, with the waxed side downwards, and a moderate degree of heat must be applied to the bottom of the basin: somewhere between 120 and 140 degrees of Fahrenheit's scale will be found most eligible. Perhaps the best means of providing a steady heat for this purpose is offered by the sand-bath, which was used for heating the glass before applying the wax. On this subsequent occasion, however, the temperature must never be sufficiently high to melt the wax, which in that case would run over the glass, and wholly destroy the effect of the etching.

Very soon after this application of heat, fumes of fluoric acid will arise copiously from the basin, and attack the unprotected portions of the glass. When the basin and its contents are once thoroughly warmed, the heat of the sand-bath may be advantageously diminished.

After the glass has been thus exposed during half an hour, it may be removed from the basin; and first being rinsed in water, for the purpose of diluting or washing away the fluoric acid, the wax may be scraped off with a common table-knife; the design will then be found perfectly etched upon the surface of the glass.

A metallic basin will answer perfectly for generating the fluoric acid; but it will be altogether improper to use any glazed vessels for the purpose, as the vitreous coating of such would be entirely destroyed.

In performing this process, it is necessary to use some caution; as fluoric acid, if brought into contact with the skin, will quickly disorganise it, and produce wounds which may be painful and troublesome; a very little carefulness will, however, suffice for preventing any accident of this nature.

When it is required thus to engrave other than plane surfaces, another arrangement must be provided: the glass must be exposed to the fumes of fluoric acid in some deep vessel; without, however, being suffered to come in contact with the pasty compound whence the acid fumes arise, and the whole should be covered over, to confine and retain those fumes, so that they may fully act upon the glass.

PREPARATION OF PIGMENTS.

Chromate of Lead.—This color is found quite perfect in its natural state; that of commerce is an artificial production. In its natural state it has long been known as "Siberian red lead." In 1797 *M. Vauquelin* analysed it, and found it to be a combination of oxide of lead and an acidifiable metal, to which he gave the appellation of "chrome," because of the various colors which the different preparations assumed. In fact, the chromate of lead is yellow; that of mercury, red; of silver, purple; and the oxide of chrome is green, and very valuable for porcelain and enamel, because it will resist a very high temperature almost without changing.

Red lead, which was the object of M. Vauquelin's enquiries, has hitherto been found only in Siberia, and even there it is not common; so that the laborious research of this learned chemist would not have been of much advantage to painters, if it had not been for the discovery, in France, of a mineral containing a considerable portion of oxide of chrome,

mixed with oxide of iron. It has also been found in the United States of America, chiefly in Maryland; and it is from Baltimore that the greater portion of this substance is exported. The chromate of lead is prepared with this mineral by the union of the acid with oxide of chrome, and at the same time combining potass with the acid; then decomposing the chromate of potass with soluble salt of lead.

For this purpose, one half part of the nitrate of potass is to be mixed with one entire part of the earth containing oxide of chrome. This mixture is then to be calcined in a close crucible, and the substance is afterwards to be washed in warm water, filtered, and thrown into a solution of acetate, or nitrate of lead; and nothing more is required to complete the operation than to wash the precipitate. In proportion as the chromate of potass is in the neutral state, or that of subchromate, and according as the precipitation is made in cold or warm water, the tint will vary, from a delicate clear yellow to that of orange color.

It is not, however, a permanent color, and is less so in proportion to the oxide of lead it contains. In a few years its brightness goes off, and it becomes like yellow ochre; but when combined with alumine, it continues brilliant for a much longer period.

Mineral Yellow (Chloride of Lead).—This is a combination of lead and chlorine. It is prepared in various ways: the following method by M. Chaptal is one of the oldest on record:—

Four parts of litharge, reduced to an impalpable powder, are moistened with one part of marine salt, dissolved in four of water.

It is then formed into a thin paste, and to remain undisturbed until it begins to whiten; it must then be stirred well with the spatula, to prevent it growing too hard.

In proportion as the consistency increases, salt is added; and if it appears that there is not sufficient of this ingredient, water must be added to retain the paste in a proper condition. In about twenty-four hours this compound should have become well bleached, very compact, and quite free from lumps: but it must still be stirred occasionally, to complete the decomposition: it is then to be carefully washed, to deprive it of the soda, which will be found separated from the marine salt, and the white paste must then be placed to drain on a filter.

When dry, it is reduced to powder, and exposed in the receiver of a reverberatory furnace, until it assumes the yellow color required; this powder is then to be thrown into a crucible which has been brought up to a red heat, and is then returned into the furnace, where it is only allowed to remain until the composition has melted; thus fused, it is thrown on a plate of iron; and when cool, it forms a crystalline mass striated transversely.

The following is another method of producing this pigment:—

Acetate of lead is first decomposed by marine salt: the chlorine, as in the former instance, is separated from the soda, and forms a new combination with the lead; this chloride of lead is then carefully washed, and when dry is mixed with a certain quantity of pulverized litharge; it is then melted quickly in a crucible, and thrown upon a plate of iron; but according as the mixture is exposed for a longer or shorter time to the action of fire, the shade of color will be lighter or darker; the heat is therefore to be kept equal; the crucibles are heated to red at first, and withdrawn at the same time.

In the following process bismuth and antimony are used, and should have the effect of rendering the color more permanent. They are ground apart, that the proportions may be exactly ascertained, which are as follows:—

Bismuth, ...	3 parts
Sulphuret of antimony, ..	24
Nitrate of potass, ...	64

This mixture is to be dropped by degrees into a heated crucible; when dissolved, it must be thrown into a vessel of water, where it is to remain, and must be well stirred for the requisite time.

It must then be repeatedly decanted until the water has lost all its smell; it is then to be filtered, and the oxide thus obtained is a fine powder, of an impure yellow tint.

An eighth part of this oxide perfectly dry, is then mixed with one part of muriate of ammonia, and sixteen parts of very pure litharge.

The fusion is then to be carried on as in the English process: great care must be taken, however, that the degree of heat, and the duration of the process, shall be exactly the same. It is as well to be aware, that the best crucibles will not be able to sustain more than three or four operations; and also, that they do not stand the heat, if kept exposed to the fire during a longer time than is required to fuse the mixture. Fifty years ago the mineral yellow was not known; it is not so permanent as Naples yellow, and grows paler in time; it may be used with the latter color and with the ochres.

Naples Yellow.—The discovery of this color belongs to high antiquity, even so far back as the earlier working of enamel. The Italians give it the name of Giallolino; *Cennino Cennini* writes it so: Paul Lomazzo styles it *Gialliolina di Furnace di Fiandra e di Allamagna;* but it is probable that when the French artists began to use this color, they obtained it direct from Naples, where perhaps it was made of a better quality than elsewhere.

There is in the Memoirs of the Academy of Sciences, A. D. 1772, an account of a process communicated by M. Fougeroux de Bondaroy: it is as follows:—

Ceruse	12 oz.
Sulphuret of antimony	2
Calcined alum	0 ½
Sal ammoniac	1

"These materials must all be reduced to powder, then mixed in exact proportions, and placed in an earthen pan covered with a lid of the same material: this pan is then to be placed in a potter's furnace, where it is to be calcined, first at a low heat, increasing it by degrees, until the vessel has assumed a moderately red appearance; it will require three hours of this calcination before this mixture is properly prepared.

"The product of this operation will be a fritty substance, of a golden yellow hue; this frit is then thrown into water, to separate it from whatever salts it may contain; it is then ground, and its tint becomes much paler." This process has been repeated exactly as directed, but without success.

M. Fougeroux has translated into the word *alum*, the Italian expression, which in the receipt given to him, was doubtless, *allume de fecia*, that is, "salt of tartar;" he is also mistaken in naming "*sulphuret* of antimony" amongst the ingredients, it is the "*oxide* of antimony" that should be used.

In a collection of receipts relative to various processes of the arts, printed at Venice, in 1753, is a memoir of Passari on the manufacture of *faience;* mention is also made in it of the materials for compounding Naples yellow. According to that author it is thus prepared:—

Antimony..................	1 *lb.*
Lead....................	1½
Common salt	1 *oz.*
Tartrate of potass	1

Passeri observes, that by changing the proportions, the yellow obtained will be of a more or less golden hue. In four out of the six receipts which he gives, there is no mention whatever of marine salt; the effect of this salt would be to render the color more clear, but less rich, because it produces a portion of chloride of lead (mineral yellow) which takes away the golden tint that originally characterises the combination of the oxides of lead and antimony.

In the manufacturing of Naples yellow, it is of great consequence that the lead and antimony should be in the complete state of oxides; they must be intimately blended together in the grinding, and afterwards passed through a silken sieve; the mixture is then to be laid in a vessel of unglazed earthenware covered up, and placed in a potter's oven, in the least heated part of it, to prevent the danger of the fusion and de-oxidation of the lead.

The yellow used in enamel painting, is very similar to Naples yellow; it is composed of the oxides of antimony and lead; by varying the proportions, and also the duration of its exposure to the fire, different shades are produced.

M. Guimet's yellow of antimony, which bears a fine golden tint, more intense than that of Naples yellow. It is prepared as follows:—

Antimoniate of potass, or diaphoretic antimony, (carefully washed,)	1 part.
Pure minium, ...	2 parts.

These ingredients must be mixed carefully together, and ground, upon a marble flag, to the consistence of paste; this paste is then to be dried, reduced to a powder, and exposed to a moderate red heat during four or five hours, taking care to regulate the fire in such a manner as to prevent its rising to a temperature sufficient to carry off the oxygen of the lead and antimony.

M. Guimet thinks that the deutoxide of antimony, and the oxide of lead, are alone sufficient to produce as strong a yellow, it appearing to him, that the potass has no other action in this case than that of completely oxidising the antimony, which process is indispensable to the success of the operation.

Iodide of Lead.—This color, which is not yet much known in commerce, is as bright as orpiment or chromate of lead. It is thought to be more permanent; but time only can prove its pretensions to so essential a quality. It is prepared by precipitating a solution of acetate or nitrate of lead, with hydrochlorate of potass: the nitrate produces a more brilliant yellow color.

(To be continued.)

COPPER-PLATE PRINTING INKS.

To the Editor.

SIR.—If the following receipts are useful they are much at your service, they may be depended upon.

Black.—Frankfort black, finely ground with boiled linseed oil, or (for very fine work) fat oil.

Red.—Mineral orange red, 5 oz.—Chinese red, 2 oz.

Blue.—Celestial blue, 2 oz.—marine ditto, 3 oz.

Green.—Mineral green, 2 oz.—chrome ditto, 3 oz.

Brown.—Burnt umber, 2 oz.—rose pink, 1 oz.

Lilac.—Prussian blue, 1 oz.—Chinese red, 2 oz.

Pink.—Mineral pink, 2 oz.—satin white, 1 oz.

Orange.—Orange red, 2 oz.—flake white, 1 oz.

[The above seven to be ground and mixed with Canada balsam.]

Or, *Red.*—Vermillion.

Yellow.—King's yellow.

Blue.—Smalts.

Green.—King's yellow—green.

Blue.—Prussian blue, and flake white.

Brown.—Burnt umber.

Do. Darker.—Ditto, and Frankfort black.

Puce.—Frankfort black, and vermillion.

Brown.—Frankfort black, and drop lake.

[The above to be ground and mixed with nut or linseed oil.]

Gold.—Gold bronze mixed with dark oak and mahogany varnish.

Silver, Copper, Ruby, &c.—The same as for gold, merely substituting the different bronzes.

Note.—Cards printed in gold, silver, &c., should, when dry, be placed on a very smooth copper, or still better, steel plate (not engraved) and passed through a copper-plate press with rather a *tight* pressure—this would also improve the appearance of cards printed in like manner with letter-press.

To Clean Copper-plates.—Copper-plates are cleaned by laying them on the hob near the fire, and pouring on them some spirits of tar, and then rubbing them with a small soft brush. G. CLARKE.

[*Painting on Vellum.*—The illuminated missals, or coats of arms, &c., on vellum may be best done by the above colors, rather than by water colors with gall in them as is often practised—the colors being put on with a brush as in ordinary painting, also if more brilliancy be required for gold and silver, those metals may be put on in leaf, a coat being first put on with gold size—gold is best shaded with a bright transparent brown—silver with green; they are also in a considerable degree the same colors as are used by Mr. Baxter, in his beautiful art of Oil Color Printing.—ED.]

QUERIES.

207—Why are vegetable fibres, such as Russia matting, &c., stronger when wet than when dry?

208—How is sand paper for lighting lucifers made?

209—How are plaster casts from life taken?

210—How is Marder's waterproof jet made?—[We are inclined to think that this is nothing more than the German blacking, for which there is a receipt in No. 48.—ED.]

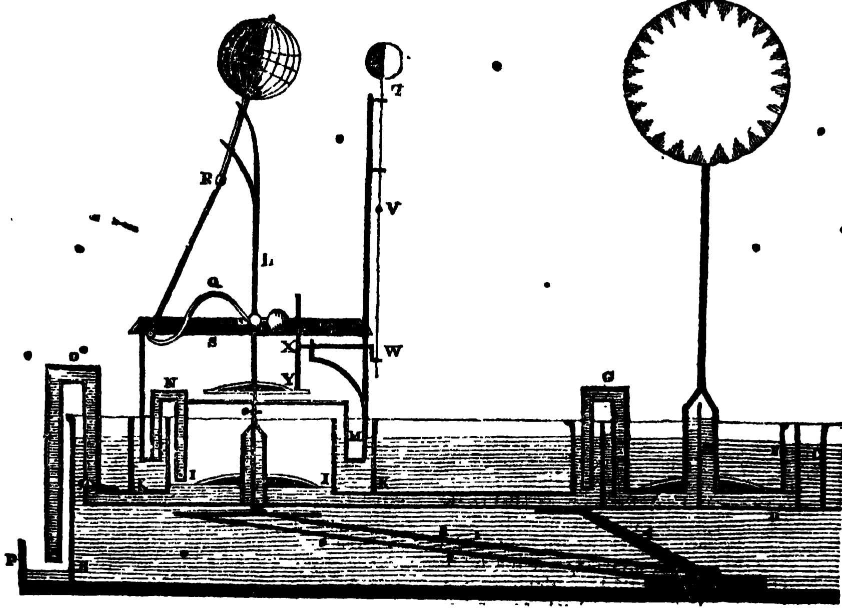
211—How is gold colored?

212—How is jewellers' cement made?

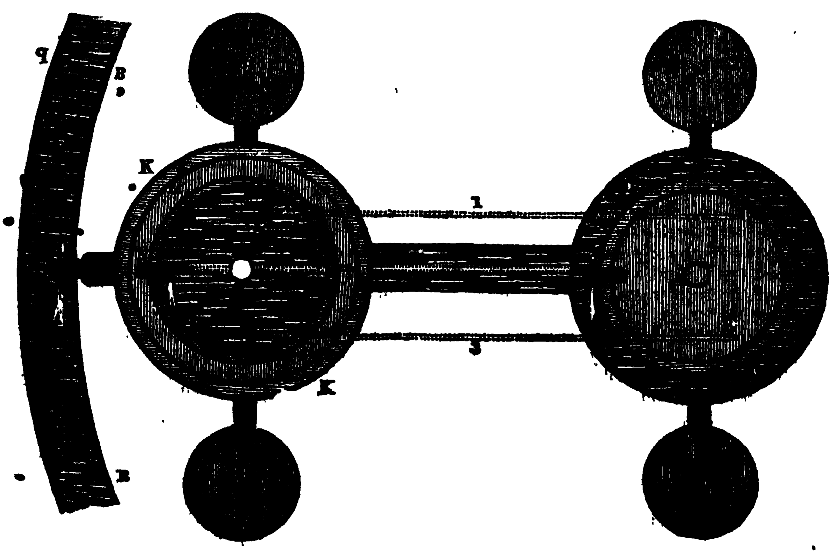
213—How is blocking cement used by the gun engraver's made?

MISCELLANIES.

Nature of the light emitted by lime, in a high state of incandescence.—Mr. Herschel, upon examining the light from lime obtained by Lieutenant Drummond, found that it contains all the usual rays, and three of those remarkable in quantity and quality, viz. the *red*, the *yellow*, and the *green*. The red is intermediate between the red and orange of the solar spectrum, but is nearer to the latter. It is remarkable, as Mr. Herschel mentions, that a red of the above character is yielded by lime itself, whilst the colour given to burning bodies by the combinations of that earth is a brick red.



BUSBY'S HYDRAULIC ORRERY.



BUSBY'S HYDRAULIC ORRERY.

BY THE INVENTOR.

To the Editor.

Explanation of the Motive Principle of the Hydraulic Orrery.—SIR.—Some time since I was engaged, during my stay at New York, in a course of experiments to determine the resistance opposed to solid bodies of various forms, in their passage through fluids. To perform these in the most simple and effectual manner, I provided a large bason or circular reservoir, and placed therein near the circumference, any floating vessel that happened to be the subject of trial. This vessel was connected by an arbor to a floating centre, held in its place by a small shaft passing through it, and erected perpendicularly from the bottom of the reservoir. The bottom of the floating vessel was pierced, and a syphon which it carried, being soldered into the aperture, rose from it, and extending over the circumference of the reservoir, its other extremity depended in air at a lower level than the surface of the water. This outer leg of the syphon was closed at the bottom; but a minute lateral aperture, resembling a very small finger-hole of a flute, being made, the water spouted through it (when the syphon was charged) in a direction parallel to the vessel, which instantly began to move with accelerated velocity in an opposite course. In a few seconds a maximum was attained, and the future progress exhibited that beautiful, continuous movement which can only find an adequate comparison in the silent gliding of the heavenly spheres. The idea instantaneously impressed me, and has been subsequently embodied, with the most encouraging success, in the novel machine above-mentioned.

At present I have applied the principle, under appropriate modifications, no farther than to the Sun, the Earth, and the Moon, whose circuits, obliquities, parallelisms, and rotations, are displayed in apparently spontaneous movements on an area of five feet diameter. To effect these, three floating syphons are so combined in succession, that a quantity of water equal to the discharge of a single stream about one-eighth of an inch diameter, with a head of about seven inches, elicits every action. Each motion, as in nature, is perfectly independent; any one may be checked without impeding another; and when the hydraulic orrery commences its operations, it practically illustrates those incipient and gradually accelerating movements, which may be supposed to have taken place within the mighty system itself, when, as in the beginning, the maximums of the greater motions were probably attained in succession.

This motive principle (founded on Barker's mill, but now first combined with a syphon, and applied to a floating body) is applicable to an extensive variety of experimental and philosophical purposes. It is so truly equable, that by means of it I make the novel and interesting experiment of producing a perfect hydroparabolic mirror fifty-four inches diameter, and thus create any magnifying power *ad libitum*. Whirling tables upon this principle will preserve any particular velocity, during any required period of time, and the motion permits the most minute regulation, either by a variation in the length of the syphon, or of the size of the discharging aperture; or by so fixing a small flexible inclined plane to the syphon itself, and bending it into the stream, as that any proportion of its re-action may be neutralized by its action.

Another mean of obtaining an universal standard of measure is hereby provided independently of the pendulum. Thus a given parabolic speculum will invariably be formed by any given rotation at any known level and latitude, and the focal distance of any parabola must under those circumstances be always a given dimension. A graduated revolving circle will also practically measure such minute portions of time as are beyond the recognition of the most accurate astronomical clocks. The hydraulic orrery, when in action, lowers the surface of the water upon which it floats about one inch in an hour; it is effectually stopped by blowing air into the syphons, or by preventing the efflux of water in any other manner.

Construction of the Hydraulic Orrery.—The Engraving contains the plan and section of the apparatus; the same letters are used to point out the corresponding parts of the figures 1 and 2.

There must first be imagined a circular reservoir 5 feet diameter, of which E is the centre, and B B parts of the circumference; C C is a circular gutter (11 inches internal, and 9 inches external diameter) floating concentrically in the reservoir; D is a bar fixed diametrically across the bottom of the inner circle formed by the gutter C C, from the middle of this bar a small shaft E is erected; F F is a cylindrical floating vessel 8½ inches diameter, a tube is soldered into an opening (one inch diameter) in the centre, the top of this tube is closed, except a small hole through which the shaft E passes, and acts as a pivot; a cap covers the central tube, and terminates in a rod surmounted by a ball (9 inches diameter) representing the Sun; G is a syphon soldered into an aperture in the floating cylinder F F, and balanced by a weight on the opposite side; the other leg of this syphon hangs over into the circular gutter C C, into which it discharges a minute *lateral* stream of water, the re-action of which stream gives a rotatory motion to the vessel F F, and consequently to the ball which it carries. The water discharged into the gutter C C, passes away through the tube H, beneath the surface of the great reservoir, and enters the floating cylindrical chamber I I; this chamber is 8 inches diameter, is surrounded by a second cylinder K K 11 inches diameter, but the water of the great reservoir is admitted through large apertures beneath into the intervening space.

In the centre of the chamber I I, a tube one inch diameter is erected, closed above and below, except small central openings through which the shaft L passes, ultimately bearing a 3 inch ball representing the Earth. In the circular space between the cylinders I I and K K, floats a ring M M, a bar extends diametrically across the upper part of this floating ring, and the shaft L acts as its pivot through a central opening. Upon this ring is erected a small shaft bearing a ¾ inch ball representing the Moon.

On an opposite part of the ring, one leg of a syphon is soldered into an aperture, while the other leg hangs over into the chamber I I, into the lower part of which it discharges a small stream *laterally*; the re-active force of this stream causes the ring to revolve, and, consequently, to carry the ball representing the Moon round that by which the Earth is designated.

The water now brought into the chamber I I, by the two syphons which move the balls representing the Sun and Moon, is carried away by a great syphon

O, communicating with it by a short horizontal tube; this water is discharged *laterally* at a lower level from the great syphon into an external gutter P placed to receive it, and its re-active impulse gives motion to the whole apparatus, and causes it to perform a circuit in the great reservoir representing the annual orbits of the Moon and Earth about the Sun.

The parallelism of the Earth's axis is effected, by fixing a circulate plate (6 inches diameter) to the lower extremity of the rod L, and connecting its circumference by three equal oblique rods 1, 2, 3, with that of another circular plate fixed to the centre of the bottom of the reservoir; thus is formed a sort of circular parallel rule, which produces the desired effect; the lateral confinement of the central part of the apparatus being effected by means of the inclined forked brace 4, shaped like a spur, and clasping the fixed plate, itself being fixed to the inner extremity of the tube H upon a hinge incapable of lateral action.

The longer arm of the steel-yard Q (attached to the shaft L, and moveable on a vertical joint) sustains the lower extremity of a slender rod connected by an universal joint R with the axis of the 3 inch globe—a small wheel is fixed upon this rod towards the lower end, and the conical rim S, borne by and revolving with the circular shaft which carries the Moon, acts upon the little wheel by contact with the edge, gives it a rotatory motion, communicated immediately through the universal joint to the globe above, while the shorter arm of the steel-yard is balanced by a weight just sufficient to keep the wheel slightly pressed against the rim.

The obliquity of the Moon's path is imitated, by causing the auxiliary rod sustaining the smallest ball to slide up and down through two projections from the main standard as she revolves; this is effected by making a joint at V, and attaching the lower extremity to a revolving crank W, this crank is fixed to the continued axle of a thin vertical wheel X rolling on the horizontal circle Y, which is itself fixed to, and borne by, the shaft supporting the Earth.

The change of the Moon's nodes is performed by making a due variation between the diameter of the vertical wheel, and that of the circle upon which it rolls. The four balancers (5, 6, 7, 8,) are added, for the purpose of keeping the apparatus steady, by a necessary extension of the floating base.

OBJECTS FOR THE KALEIDOSCOPE.

(Resumed from page 118.)

Although the Kaleidoscope is capable of creating beautiful forms from the most ugly and shapeless objects, yet the combinations which it presents, when obtained from certain forms and colours, are so superior to those which it produces from others, that no idea can be formed of the power and effects of the instrument, unless the objects are judiciously selected.

When the inclination of the reflectors is great, the objects, or the fragments of coloured glass, should be larger than when the inclination is small; for when small fragments are presented before a large aperture, the pattern which is created has a spotted appearance, and derives no beauty from the inversion of the images, in consequence of the outline of each separate fragment not joining with the inverted image of it.

The objects which give the finest outlines by inversion, are those which have a curvilineal form, such as circles. ellipses, looped curves like the figure 8, curves like the figure 3 and the letter S; spirals; and other forms, such as squares, rectangles, and triangles, may be applied with advantage. Glass, both spun and twisted. and of all colours and shades of colours, should be formed into the preceding shapes; and when these are mixed with pieces of flat-coloured glass, blue vitriol, native sulphur, yellow orpiment, differently coloured fluids enclosed and moving in small vessels of glass, &c. they will make the finest transparent objects for the Kaleidoscope. When the objects are to be laid upon a mirror plate, fragments of opaquely-coloured glass should be added to the transparent fragments, along with pieces of brass wire, of coloured foils, and grains of spelter. In selecting transparent objects, the greatest care must be taken to reject fragments of opaque glass, and dark colours that do not transmit much light; and all the pieces of spun glass, or coloured plates, should be as thin as possible.

When the objects are thus prepared, the next step is to place them in the object plates. The distance between the interior surfaces of the two plane glasses, of which the object plates are composed, should not exceed 1-8th of an inch. The thickness of the transparent glass next the reflectors should be just sufficient to keep the glass from breaking; and the interior diameter of the brass rings, into which the transparent and the grey glass are burnished, should be so great that no part of the brass rim may be opposite the angular part of the reflectors during the rotatory motion of the cell. If this precaution is not attended to, the central part of the pattern, where the developement of new forms is generally the most beautiful, will be entirely obliterated by the interposition of the brass rim. When the two parts of the object plate are screwed together, it should be nearly two-thirds filled with the mixture of regular and irregular objects, already mentioned. If they fall with difficulty during the rotation of the cell, two or three turns of the screw backward will relieve them; and if they fall too easily, and accumulate, by slipping behind one another, the space between the glasses may be diminished by placing another glass in contact with the grey glass.

When the object plate, now described, is placed in the cell, and examined by the Kaleidoscope, the pictures which it forms are in a state of perpetual change, and can never be fixed, and shown to another person. To obviate this disadvantage, an object plate with fixed objects generally accompanies the instrument; the pieces of spun and coloured glass are fixed by a transparent cement to the inner side of the glass of the object plate, next the eye, so that the patterns are all permanent, and may be exhibited to others. After the cell has performed a complete rotation, the same patterns again recur, and may therefore be at any time recalled at the pleasure of the observer. The same patterns, it is true, will have a different appearance, if the light falls in a different manner upon the objects, but its general character and outline will remain the same.

The object plates, which have now been described, are made to fit the cell, but at the same time to slip easily into it, so that they themselves have no motion separate from that of the cell. An object plate, however, of a less diameter, called the vibrating object plate, and containing loose objects, is an in-

teresting addition to the instrument. When the Kaleidoscope is held horizontally, this small object plate vibrates on its lower edge, either by a gentle motion of the tube, or by striking it slightly with the finger; and the effect of this vibration is singularly fine, particularly when it is combined with the motion of the coloured fragments.

Another of the object plates, in several of the instruments, contains either fragments of colourless glass, or an irregular surface of transparent varnish or indurated Canada balsam. This object plate gives very fine colourless figures when used alone; but its principal use is to be placed in the cell between an object plate with bright colours and the end of the instrument. When this is done, the outline of the pieces of coloured glass are softened down by the refraction of the transparent fragments, and the pattern displays the finest effects of soft and brilliant colouring. The colourless object plate supplies the outline of the pattern, and the mass of colour behind fills it up with the softest tints.

Some of the object plates are filled with iron or brass wires, twisted into various forms, and rendered broader and flatter in some places by hammering. These wires, when intermixed with a few small fragments of coloured glass, produce a very fine effect. Other object plates have been made with pitch, balsam of tolu, gum lac, and thick transparent paints; and when these substances are laid on with judgment, they form excellent objects for the Kaleidoscope. Lace may be introduced with considerable effect, and also festoons of beads strung upon wire or thread; but pieces of glass, with cut and polished faces, are entirely unfit for objects.

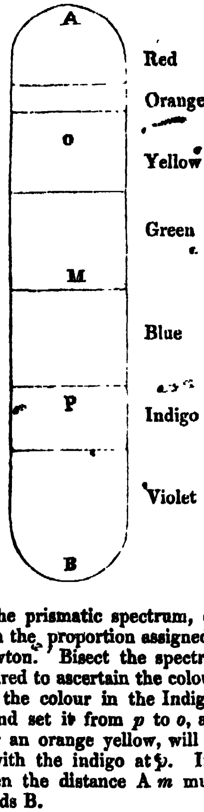
Hitherto we have supposed all colours to be indiscriminately adopted in the selection of objects; but it will be found from experience, that though the eye is pleased with the combination of various objects, yet it derives this pleasure from the beauty and symmetry of the outline, and not from the union of many different tints. Those who are accustomed to this kind of observation, and who are acquainted with the principles of the harmony of colours, will soon perceive the harshness of the effect which is produced by the predominance of one colour, by the juxta-position of others, and by the accidental union of a number; and even those who are ignorant of these principles, will acknowledge the superior effect which is obtained by the exclusion of all other colours except those which harmonise with each other.

In order to enable any person to find what colours harmonise with each other, the following table, which contains the harmonic colours, has been drawn up:

Deepest Red	Blue and Green equally mixed
Red	Blue unmixed
Orange Red	Blue mixed with much Indigo
Orange	Blue and Indigo, the Indigo predominating
Orange Yellow	Indigo unmixed
Yellow	Violet and Indigo nearly in equal portions
Greenish Yellow	Pale Violet
Green	Violet
Greenish Blue	Violet and Red in equal portions
Blue	Red
Indigo	Orange Yellow
Violet	Green.

It appears from the preceding table that *Blue* harmonises with *Red*, or in other words, *Red* is said to be the *accidental colour* of *Blue*, and *vice versa*. These colours are also called *complementary colours*, because the one is the complement of the other, or what the other wants of white light; that is, when the two colours are mixed, they will always form white by their combination.

The following general method of finding the harmonic colours will enable the reader to determine them for tints not contained in the preceding table:



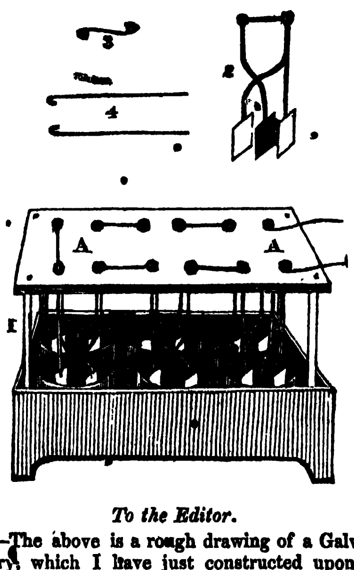
Let A B be the prismatic spectrum, containing all the colours in the proportion assigned to them by Sir Isaac Newton. Bisect the spectrum at *m*, and let it be required to ascertain the colour which harmonises with the colour in the Indigo space at *p*. Take A *m* and set it from *p* to *o*, and the colour opposite *o*, or an orange yellow, will be that which harmonises with the indigo at *p*. If *p* is between *m* and A, then the distance A *m* must be set off from *m* towards B.

In order to shew the method of constructing object plates on the preceding principles, we shall suppose that the harmonic colours of orange yellow and indigo are to be employed. Four or five angular figures, such as those already described, must be made out of indigo coloured glass, some of them being plain, and others twisted. The same number of figures must also be made out of an orange yellow glass; and some of these may be drawn of less diameter than others, in order that tints of various intensities, but of the same colour, may be obtained. Some of these pieces of spun glass, of an indigo colour, may be intertwisted with fibres of the orange yellow glass. A few pieces of white flint glass, or crystal spun in a similar manner, and intertwisted, some with fibres of orange yellow, and others with fibres of indigo glass, should be added; and when all these are joined to some flat fragments of orange yellow glass, and indigo coloured glass, and placed in the object plate, they will exhibit, when applied to the Kaleidoscope, the most chaste combinations of forms and colours, which will not only delight the eye by the beauty of their outline, but also by the perfect harmony of their tints.

The effect produced by objects of only one colour is, perhaps, even superior to the combination of two harmonic colours. In constructing object plates of this kind, various shades of the same colour may be adopted; and when such objects are mixed with pieces of colourless glass, twisted and spun, the most chaste and delicate patterns are produced; and those eyes which suffer pain from the contemplation of various colours, are able to look without uneasiness upon a pattern in which there is only one.

In order to shew the power of the instrument, and the extent to which these combinations may be carried, a long object plate has been constructed, like the slider of the magic lanthorn, in which combinations of all the principal harmonic colours followed one another in succession, and presented to the eye a series of brilliant visions no less gratifying than those successions of musical sounds from which the ear derives such intense delight.

NEW GALVANIC BATTERY.



To the Editor.

SIR.—The above is a rough drawing of a Galvanic Battery, which I have just constructed upon the principle of Smee, but which I think more simple in its arrangements, more convenient, and more effectual than any other I have seen. To those of your readers who may be desirous of possessing such a battery, I have no hesitation in saying that this will prove highly satisfactory; I therefore feel a pleasure in furnishing them with the necessary instructions for making one.

First procure ½ doz. 1 lb pots (ordinary jelly pots); get a mahogany stand, No. 1, made with partitions to hold them. The dimensions of mine are 14 inches long, 9½ inches wide, about 4 inches high; top board with supports about 4½ inches high, with pins at each end, so that the top may be lifted on and off easily. Then procure 12 pieces of silver plate about 2½ inches square, and about the thickness of a sixpence—half that thickness would do, but from their being thicker they are less liable to be bent. Cast some zinc plates, let them be about 3 inches square, and about ¼ inch thick, and connect them together on the top board (fig. 2), so that 1 piece of zinc be between 2 silver plates in each pot (fig. 3). The connecting wires should be good stout ones; they may be bent (as fig. 4), placed on the tops of the wires as they come through the board, and screwed down with the brass balls A A. . The conducting wires, or poles, may be bent in the form of a hook (fig. 5), either screwed down, or made to touch the brass balls only. The silver plates should be coated with platina before using, which may be very easily done: procure some solution of platina (nitromuriate), a porous jar and tumbler, put the jar inside the tumbler, fill it with dilute sulphuric acid, and outside of it in the tumbler pour some dilute acid, as much as will cover the silver plate, add a little of the solution of platina; then, in the porous jar immerse a piece of zinc, and in the tumbler the silver plate, connect them together, when a violent action will commence; and, in a short time, the silver plate will be sufficiently covered as to be taken out and replaced by another. Lastly, the zinc plates should be well amalgamated with mercury, taking care not to let any get on the silver.

To excite its action pour into each pot 2 oz. of sulphuric acid (oil of vitriol), fill up with water, and immerse your plates. It will maintain its action for days together, if when the battery be done with the board be slipped off and immersed in water.

A great deal of trouble I consider is saved by this battery, and from its construction one or two, or the whole of the pots may be used, which is not the case with the trough battery, as that is obliged to be wholly charged. Its effects are astonishing, igniting a piece of stout iron wire 6 inches in length.

I. HORSLEY, Chemist.

Ryde, Isle of Wight.

FLUID SUPPORT—SWIMMING.

THE human body, in an ordinary healthy state with the chest full of air, is lighter than water..

If this truth were generally and familiarly understood, it would lead to the saving of more lives, in cases of shipwreck and in other accidents, than all the mechanical life-preservers which man's ingenuity will ever contrive.

The human body with the chest full of air naturally floats with a bulk of about half the head above the water,—having then no more tendency to sink than a log of fir. That a person in water, therefore, may live and breathe, it is only necessary to keep the face uppermost. The reasons that in ordinary accidents so many people are drowned who might easily be saved, are chiefly the following:—

1st. They believe that the body is heavier than water, and therefore that continued exertion is necessary to keep it from sinking; and hence, instead of lying quietly on the back, with the face upwards, and with the face only out of the water, they generally assume the position of a swimmer, in which the face is downwards, and the whole head has to be kept out of the water to allow of breathing. Now, as a man cannot retain this position but by continued exertion, he is soon exhausted, even if a swimmer, and if he is not, the unskilful attempt will scarcely secure for him even a few respirations. The body raised for a moment by exertion above the natural level, sinks as far below it when the exertion ceases; and the plunge, by appearing the

commencement of a permanent sinking, terrifies the unpractised individual, and renders him an easier victim to his fate.—To convince a person learning to swim of the natural buoyancy of his body, it is a good plan to throw an egg into water about five feet deep, and then to desire him to bring it up again. He discovers that instead of his body with the chest full of air naturally sinking towards the egg, he has to *force* his way downwards. and is lifted again by the water as soon as he ceases his effort.

2d. They fear that water entering by the ears may drown, as if it entered by the nose or mouth, and they make a wasteful exertion of strength to prevent it; the truth being, however, that it can only fill the outer ear, as far as the membrane of the drum, where its presence is of no consequence. Every diver and swimmer has his ears thus filled with water, and cares not.

3d. Persons unaccustomed to the water, and in danger of being drowned, generally attempt in their struggle to keep their hands above the surface, from feeling as if their hands were imprisoned and useless while below; but this act is most hurtful, because any part of the body held out of the water, in addition to the face which must be out, requires an effort to support it, which the individual is supposed at the time ill able to afford.

4th. They do not reflect, that when a log of wood or a human body is floating upright, with a small portion above the surface, in rough water, as at sea, every wave in passing must cover it completely for a little time, but will again leave its top projecting in the interval. The practised swimmer chooses this interval for breathing.

5th. They do not think of the importance of keeping the chest as full of air as possible; the doing which has nearly the same effect as tying a bladder of air to the neck, and, without other effort, will cause nearly the whole head to remain above the water. If the chest be once emptied, while from the face being under water the person cannot inhale again, the body remains specifically heavier than water, and will sink.

When a man dives far, the pressure of deep water compresses, or diminishes the bulk of the air in his chest, so that without losing any of that air, he yet becomes really heavier than water, and would not again rise, but for the exertion of swimming. Dr. Arnott mentions, that he once saw a sailor (a fine-bodied West India negro) fall into the calm sea from a yard-arm eighty feet high. The velocity on his reaching the water was so great, that he shot deep into it, and, of course, his chest was compressed as now explained: probably also the shock stunned him, for although he was an excellent swimmer, he only moved his arms feebly once or twice, and was then seen gradually sinking for a long time afterwards, until he appeared only as a black and distant speck, descending towards the unknown regions of the abyss.

Every person needs not learn to swim; but every one who makes voyages should have practised the easy lesson of resting in the water with the face out. The head, from the large quantity of bone in it, is a heavy part of the body, yet, owing to its proximity to the chest, which is comparatively light, a little action of adjustment with the hands easily keeps it uppermost; and there is an accompanying motion of the feet, called *treading the water*, not difficult to learn, which suffices to sustain the entire head above the surface. Many of the seventy passengers who were swallowed up on the sudden sinking of the Comet steam-boat near Greenock, in November 1825, might have been saved by the boats which so soon went to their assistance, had they known the truth which we are now explaining.

A man having to swim far, may occasionally rest on his back for a time, and resume his labour when he is somewhat refreshed.

So little is required to keep a swimmer's head above water, that many individuals, altogether unacquainted with what regards swimming or floating, have been saved after shipwreck, by catching hold of a few floating chips or broken pieces of wood. An oar will suffice as a support to half a dozen people, provided no one of the number attempts by it to keep more than his head out of the water; but often, in cases where it might be thus serviceable, from each person wishing to have as much of the security as possible, the number benefited is much less than it might be.

The most common contrivances, called *life-preservers*, for preventing drowning, are strings of corks put round the chest or neck, or air-tight bags applied round the upper part of the body, and filled when required by those who wear them blowing into them through valved pipes.

On the great rivers of China, where thousands of people find it more convenient to live in covered boats. than in houses upon the shore, the younger children have a hollow ball of some light material attached constantly to their necks, so that in their frequent falls overboard they are not in danger.

Life-boats have a large quantity of cork mixed in their structure, or of air-tight vessels of thin copper or tin plate; so that, even when the boats are filled with water, a considerable part still floats above the general surface.

Swimming is much easier to quadrupeds than to man, because the ordinary motion of their legs in walking and running is that which best supports them in swimming. Man is at first the most helpless of creatures in water. A horse while swimming can carry his rider with half the body out of the water. Dogs commonly swim well on the first trial.—Swans, geese, and water-fowls in general, owing to the great thickness of feathers on the under part of their bodies, and the great volume of their lungs, and the hollowness of their bones, are so bulky and light, that they float upon the water like stately ships, moving themselves about by their webbed feet as oars. A water-fowl floating on plumage half as bulky as its naked body, has above half that body above the surface of the water; and similarly a man reclining on a floating mattress, has nearly as much of his body above the level of the water-surface, as he forces of the mattress under it. His position, therefore, depends on the thickness of the mattress.

A man walking in deep water may tread upon sharp flints or broken glass with impunity, because his weight is nearly supported by the water.

But many men have been drowned in attempting to wade across the fords of rivers, from forgetting that the body is so supported by the water, and does not press on the bottom sufficiently to give a sure footing against a very trifling current. A man, therefore, carrying a weight on his head, or in his hands held over his head. as a soldier bearing his arms and knapsack, may safely pass a river, where, without a load, he would be carried down the stream.

There is a mode practised in China of cathing wild ducks, which requires that the catcher be well loaded or ballasted. Light grain being first strewed upon the surface of the water to tempt them, a man hides himself in the midst of it, under what appears a gourd or basket drifting with the stream, and when the flock approaches and surrounds him, he quickly obtains a rich booty by snatching the creatures down one by one—adroitly making them disappear as if they were diving, and then securing them below. Each bird becomes as a piece of cork attached to his body.

Fishes can change their specific gravity, by diminishing or increasing the size of a little air-bag contained in their body. It is because this bag is situated towards the under side of the body, that a dead fish floats with the belly uppermost.

Animal substances, in undergoing the process of putrefaction, give out much aeriform matter. Hence the bodies of persons drowned and remaining in the water, generally swell after a time, and rise to the surface, again to sink when the still increasing quantity of air shall burst the containing parts.

A floating body sinks to the same depth whether the mass of fluid supporting it be great or small:—as is seen when a porcelain basin is placed first in a pond, and then in a second basin only so much larger than itself that a spoonful or two of water suffices to fill up the interval between them. One ounce of water in the latter way may float a thing weighing a pound or more, exhibiting another instance of the *hydrostatic paradox*:—And if the largest ship of war were received into a dock, or case, so exactly fitting it that there were only half an inch of interval between it and the wall or side of the containing space, it would float as completely, when the few hogsheads of water required to fill this little interval up to its usual water-mark were poured in, as if it were on the high sea. In some canal locks, the boats just fit the space in which they have to rise and fall, and thus the expense of water at the lock is diminished.

The preceding examples of floating are all illustrations also of the truth that the pressure of a fluid on any immersed body is exactly proportioned to the depth and extent of the surface pressed upon. The lateral pressures just balance one another, and the upward pressure has to be balanced by the weight of the body.

ASSAYING OF METALLIC ORES.

(*Resumed from page* 126.)

Lead Ores.—As most of the lead ores contain either sulphur or arsenic, they require to be well roasted. Take a quintal of roasted ore, with the same quantity of calcined borax, half a quintal of fine powdered glass, a quarter of a quintal of pitch, and as much clean iron filings. Line the crucible with wetted charcoal dust, and put the mixture into the crucible, and place it before the bellows of a forge-fire. When it is red hot, raise the fire for fifteen or twenty minutes, then withdraw the crucible, and break it when cold.

In the humid way.—Dissolve the ore by boiling it in dilute nitrous acid; the sulphur, insoluble stony parts, and calx of iron will remain. The iron may be separated by digestion, in the marine acid, and the sulphur by digestion, in caustic fixed alkali. The nitrous solution contains the lead and silver, which should be precipitated by the mineral fixed alkali, and the precipitate well washed in cold water, dried, and weighed. Digest it in caustic volatile alkali, which will take up the calx of silver, the residuum being again dried and weighed, gives the proportion of the calx of lead, 132 grains of which are equal to 100 of lead in its metallic state. The difference of weight of the precipitate before and after the application of the volatile alkali, gives the quantity of silver, 129 grains of which are equal to 100 of silver in its metallic state.

Copper Ores.—Take an exact troy ounce of the ore, previously pulverized, and calcine it well; stir it all the time with an iron rod, without removing it from the crucible; after the calcination, add an equal quantity of borax, half the quantity of fusible glass, one-fourth the quantity of pitch, and a little charcoal-dust; rub the inner surface of the crucible, with a paste composed of charcoal-dust, a little fine powdered clay, and water. Cover the mass with common salt, and put a lid on the crucible, which is to be placed in a furnace: the fire is to be raised gradually, till it burns briskly, and the crucible continued in it for half an hour, stirring the metal frequently with an iron rod, and when the scoria which adheres to the rod appears clear, then the crucible must be taken out, and suffered to cool; after which it must be broken, and the regulus separated and weighed; this is called black copper, to refine which, equal parts of common salt and nitre are to be well mixed together. The black copper is brought into fusion, and a tea-spoonful of the flux is thrown upon it, which is repeated three or four times, when the metal is poured into an ingot mould, and the button is found to be fine copper.

In the humid way.—Make a solution of vitreous copper ore, in five times its weight of concentrated vitriolic acid, and boil it to dryness; add as much water as will dissolve the vitriol thus formed; to this solution add a clean bar of iron, which will precipitate the whole of the copper in its metallic form. If the solution be contaminated with iron, the copper must be re-dissolved in the same manner, and precipitated again. The sulphur may be separated by filtration,

Bismuth Ores.—If the ore be mineralized by sulphur, or sulphur and iron, a previous roasting will be necessary. The strong ores require no roasting, but only to be reduced to a fine powder. Take the assay weight and mix it with half the quantity of calcined borax, and the same of pounded glass; line the crucible with charcoal; melt it as quickly as possible; and when well done, take out the crucible, and let it cool gradually. The regulus will be found at the bottom.

In the humid way.—Bismuth is easily soluble in nitrous acid or aqua-regia. Its solution is colourless, and is precipitable by the addition of pure water; 118 grains of the precipitate from nitrous acid well washed and dried, are equal to 100 of bismuth in its metallic form.

Antimonial Ores.—Take a common crucible, bore a number of small holes in the bottom, and place in it another crucible a size smaller, luting them well together, then put the proper quantity of ore in small lumps into the upper crucible, and lute thereon a cover; place these vessels on a hearth, and surround them with stones about six inches distant from them; the intermediate space must be filled with ashes, so that the undermost crucible may be covered with them; but upon the upper charcoal must be

laid, and the whole made red hot by the assistance of hand-bellows. The antimony being of easy fusion is separated, and runs through the holes of the upper vessel into the inferior one, where it is collected.

Humid Assay of Arseniated Antimony.—Dissolve the ore in aqua-regia, both the regulus and arsenic remain in the solution, the sulphur is separated by filtration. If the solution be boiled with twice its weight of strong nitrous acid, the regulus of antimony will be precipitated, and the arsenic converted into an acid, which may be obtained by evaporatien to dryness.

Manganese Ore.—The regulus is obtained by mixing the calx or ore of manganese with pitch, making it into a ball, and putting it into a crucible, lined with powdered charcoal, one-tenth of an inch on the sides, and one-fourth of an inch at bottom, then filling the empty space with charcoal dust, covering the crucible with another inverted and luted on, and exposing it to the strongest heat of a forge for an hour or more.

In the humid way.—The ores should be first well roasted to dephlogisticate the calx of manganese and iron, if any, and then treated with nitrous acid to dissolve the earths. The residuum should now be treated with nitrous acid and sugar, by which means a colourless solution of manganese will be obtained, and likewise of the iron, if any. Precipitate with the Prussian alkali, and digest the precipitate in pure water; the prussiate of manganese will be dissolved, whilst the prussiate of iron will remain undissolved.

Arsenical Ores.—This assay is made by sublimation in close vessels. Beat the ore into small pieces, and put them into a matrass, which place in a sand-pot, with a proper degree of heat; the arsenic sublimes in this operation, and adheres to the upper part of the vessel; when it must be carefully collected with a view to ascertain its weight. Sometimes a single sublimation will not be sufficient, for the arsenic in many cases will melt with the ore, and prevent its total volatilization; in which case it is better to perform the first sublimation with a moderate heat, and afterwards bruise the remainder again, and expose it to a stronger heat.

In the humid way.—Digest the ore in marine acid, adding the nitrous by degrees to help the solution. The sulphur will be found on the filter; the arsenic will remain in the solution, and may be precipitated in its metallic form by zinc, adding spirit of wine to the solution.

Nickel Ore.—The ores must be well roasted to expel the sulphur and arsenic; the greener the calx proves during this torrefaction, the more it abounds in the nickel; but the redder it is, the more iron it contains. The proper quantity of this roasted ore is fused in an open crucible, with twice or thrice its weight of black flux, and the whole covered with common salt. By exposing the crucible to the strongest heat of a forge-fire, and making the fusion complete, a regulus will be produced. This regulus is not pure, but contains a portion of arsenic, cobalt, and iron. Of the first it may be deprived by a fresh calcination, with the addition of powdered charcoal; and of the second by scorification; but it is with difficulty that it is entirely freed from the iron.

In the humid way.—By solution in nitrous acid, it is freed from its sulphur; and by adding water to the solution, bismuth, if any, may be precipitated; as may silver, if contained in it, by the marine acid: and copper, when any, by iron.

To separate cobalt from nickel, when the cobalt is in considerable quantity, drop a saturated solution of the roasted ore in nitrous acid into liquid volatile alkali; the cobaltic part is instantly redissolved, and assumes a garnet colour; when filtered, a grey powder remains on the filter, which is the nickel. The cobalt may be precipitated from the volatile alkali by any acid.

(To be continued.)

MISCELLANIES.

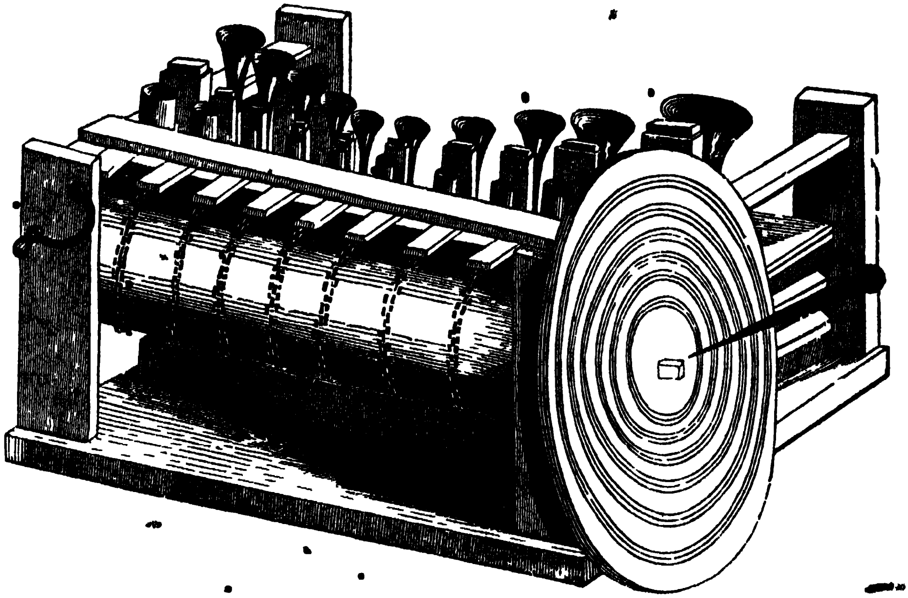
On the light developed at the separation of Boracic Acids into fragments.—M. Dumas has observed that the boracic acid, when melted, presents a particular phenomenon at the moment of its cooling. When it is cooled in a platina dish, at the instant when the contractions of the two substances becomes unequal, the boracic acid splits and discharges a bright light, which follows the direction of the cracks. This light, which is probably owing to the cause which developes the opposite electricities in plates of mica quickly separated, is sufficiently strong to be seen in the day-time. The experiment is a remarkable one in the dark.—*Ann. de Chim.* p. 324, 335.

To Clean Boot Tops, Parchment, &c.—The following mixture will readily take out grease, ink spots, and the stains occasioned by the juice of fruit, red port wine, &c. from all leather or parchment. Mix in a phial 1 drachm oxymuriate of potash, with 2 ounces of distilled water, and when the salt is dissolved, add 2 ounces of muriatic acid. Then shaking well together in another phial, 3 ounces of rectified spirit of wine, and half an ounce of essential oil of lemon; unite the contents of the two phials, and keep the liquid thus prepared closely corked for use. This chemical liquid should be applied with a clean sponge, and dried in a gentle heat. The boot tops may be polished with a proper brush, so as to appear like new leather.

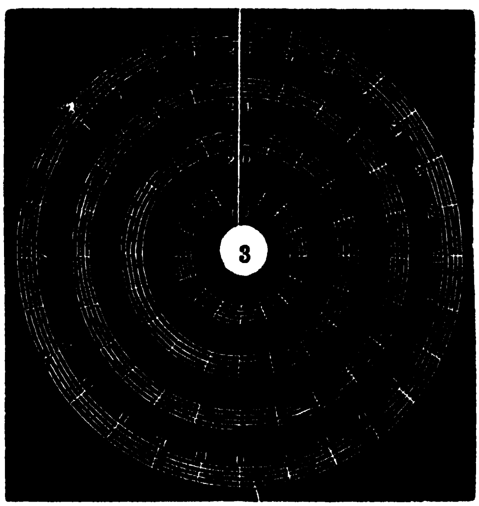
Method of Preparing Quills.—The following is the manner in which M. Scholz of Vienna proceeds in the preparation of quills for writing, by means of which he renders them more durable, and even superior to the best Hamburgh quills. For this purpose he makes use of a kettle, into which he pours common water, so as to occupy the fourth part of its capacity, he then suspends a certain quantity of feathers perpendicularly, the barrel lowermost, and so placed, as that its extremity may only touch the surface of the water; he then covers the kettle with a lid properly adjusted, boils the water, and keeps the feathers four hours in this vapour bath. By means of this process he frees them of their fatty parts, and renders them soft and transparent. On the following day, after having scraped them with the blade of a knife, and then rubbed them with a bit of cloth, he exposes them to a moderate heat; by the day after they are perfectly hard and transparent, without however having the inconvenience of splitting too easily.

Phosphoric Oil.—Put one part of phosphorus to six parts of olive oil. Set the phial for a time in a warm place—for example, a basin of warm water—when they will unite, and form a luminous and harmless fluid. The phial must always be corked when not in use.

Fig 1



PRICKING ORGAR BARRELS.



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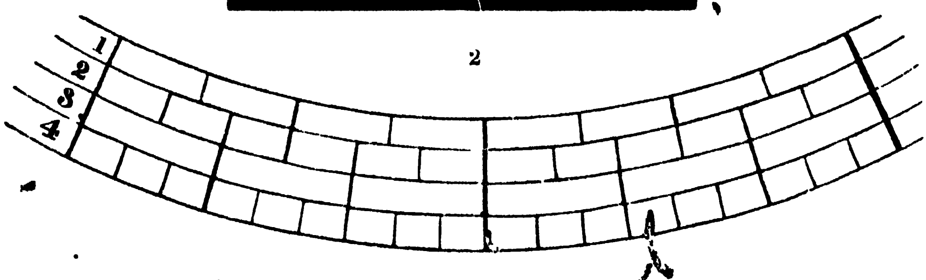


ON PRICKING ORGAN BARRELS.

The art of pricking organ barrels is confined to few hands, the operation is very simple, but requires very great attention, both in the marking and the pinning the barrel. The marking is performed by means of a flat dividing plate, about 18 inches diameter. The plate has upon it a number of groups of 5 concentric circles, each group of circles being divided into a certain number of equal parts or bars, (see Fig. 2.) These divisions are subdivided one circle (see Fig. 3) into four parts for common time, the next into six for compound common time; the third into three parts for triple time, and the fourth into nine parts for compound triple time. The wheel being thus prepared, and the barrel being covered with white paper, or painted blue, proceed to prick it thus:—Place the barrel in the organ to which it fits, the axis of the barrel being lengthened, in order that the wheel may be fastened to it by a binding screw. (The wheel is seen attached to the barrel in Fig. 1.) Thus the wheel and barrel turn round together. Then count the number of bars in the tune to be pricked, and find what group of circles agrees with that number, and which circle of that group agrees with the time of the tune. The circle to work from being thus determined, fix to the organ a piece of pointed wire, or a strip of brass like a clock-hand; so that when the wheel turns the wire may remain fixed, and so as just to touch or pass across the required circle. Every thing being now prepared, begin by ruling a straight line along the barrel; and having the written music before you, mark the first note by giving a tap with a hammer to the small lever, which is connected with the pipe representing that note: this of course will make a small mark on the barrel, then turn the wheel until the wire shows that it has travelled a space equal to the length of the note. Now stop, and give the same lever another tap, and connect the two little marks thus made by a fine line with a pen and ink, which will give the length and situation of the staple required afterwards to be driven in: thus proceed until the whole tune be complete. The pins and staples are afterwards to be put in; they are made of flattened wire, bent to their proper size with plyers; thus when the circle of the barrel is complete, the tune will be complete also. It should have been observed, that the straight line upon the barrel should be made exactly at the part where the levers touch it, when the fixed wire points at the straight line shown upon Fig. 2, and that line is to be considered as the beginning of the first bar of the tune. Also, to keep the barrel steady during the pricking of it, care must be taken to fix it by the usual stop at the end of the organ, as is done when the organ is played. Were not this carefully attended to the various pins would be apt to deviate from a right line, confusion being thereby occasioned. One tune taking up but a single line to each note, and these lines occupying but about a tenth of an inch in width, there is usually room for several tunes upon the same barrel. A second, and afterwards other tunes may, therefore, be pricked in the same manner, shifting the barrel a trifling degree sideways, so that the hammers may occupy a different portion of the surface.

To render clearer the operation take the following example:—

which, it will be seen, is the first portion of the tune, "The blue bells of Scotland." Counting the bars in the tune we find there are 16, (ordinary ballads and dances vary from 16 bars to 32, and have always an even number); therefore look on the wheel for that circle with 16 divisions—which is the inner one. As the tune is in common time, we must look for the space belonging to that group of circles which is divided into four parts; this will be found the innermost space: it is that, therefore, which we are to work from. Now, it will be seen that the tune begins with an imperfect bar, or a bar which contains only a crotchet; the due time of this will be made up at the end of the tune; it may be, therefore, at first neglected, and the pricking be begun at the next bar. Fix the barrel and wheel in their proper places, adjust the stop at the end to keep the barrel steady, and turn the handle so as to move the barrel round until the pointer coincides with the straight line marked down the wheel; there keep it steady. Ascertain (which should be done beforehand in chalk, marking each with the name of the note,) which of the hammers agrees with the note E wanted, and give it a slight tap, it will of course make an indent upon the barrel; at that mark a straight line is to be made from end to end of the barrel, that all the other tunes may be begun at the same spot, and also that the player may know the commencement of each tune, not being subjected to the awkwardness of commencing to play in the middle of a tune. Supposing, then, that the barrel has been shifted, in order to make that mark, it must be restored exactly to the same place, again the point of the hammer touching the mark it had previously made. Now turn the wheel and barrel by its usual handle, until the pointer shows the wheel to have passed over *two* spaces, that being the length of the minim E in the tune, tap the same hammer again, and join the marks it has now made to the former by a line in ink. Before moving the barrel again give D a tap, then turn the barrel round *one* space equal to the length of the crotchet D, and give a second tap; join these two marks as before, and strike C the next note; turn the wheel *one* space, and strike C again; join the two marks, and strike B the first note of the next bar. This being a minim requires *two* spaces to be passed, when it is struck again, and the two marks joined as before; the next note C is made as in the former C. To make up the time of the bar are two quavers D and E, these require only half a space in length; the other notes are to be marked in the same manner. Where a dot is placed after a note it must be half as long again. Where a rest occurs, as at the end of the example, a proportional interval must be passed over before the next note is struck. Where the music is *staccato* a very small interval is allowed between one note and another—which prevents the notes being so intimately blended together as in ordinary circumstances. In imitating the sound of bells this is to be observed.

The *appogiatura*, the *fuge*, and various of the other graces or ornaments introduced into pieces of music, may be imitated with ease by any person of common ingenuity. The flats and sharps have pipes and hammers appropriated to them. As a *shake* is

composed of two notes sounded in quick succession and alternately, it may be made by marking the notes as to their length as before; but instead of continued uniform staples to produce connected sounds from each, they must be pricked with fine pins all along, with a minute interval between each, taking care to have the pins of the one note exactly intermediate between those of the other, that a vibration of the two sounds may be produced.

The different effect of strength and softness of sound, or forte and piano, is seldom imitated in common organs; but in the best instruments it is a valuable and important feature, it may be produced by the shape, or rather the degree of prominence of the staples. If, for example, a long staple, representing a semibreve, and which we will suppose an inch in length, be inserted at an equal height from the surface of the barrel at both of its ends, it of course would lift up the hammer and valve attached to it equally all along, and the sound produced would be uniform in intensity; but if the staple be higher at one end than the other, the sound would of course increase or decrease, on account of the valve admitting at one time more wind to the pipes than at another.

Sometimes overtures, and other long pieces of music, are pricked upon the barrels of organs. No difference of the method of proceeding is to be noticed. The slight variation being in the stop at the end, which in the case of ordinary tunes is made with cuts or channels into which a brass stop works, allowing the barrel to turn round, but not to move laterally: but in a barrel prepared for an overture the stop is made of a screw, so that the barrel, when it has made one revolution, has also moved laterally one thread of the screw, whereby the teeth of the hammers take hold of a different range of staples. In playing an overture it is to be remarked, that when completed the player must stop and shift the barrel to its original position before recommencing it.

Note.—The barrels of organs are always made of very dry alder wood, which never splits, and allows the staples to be driven in easily. The flattened brass wire, and every other similar material, both for the use of the musical instrument maker and the galvanist, may be purchased of a person who lives opposite Long Acre, in Drury Lane, London. Flattened wire costs about 3s. per lb, and 1 lb will suffice for many tunes.

PREPARATION OF PIGMENTS.

(Resumed from page 136.)

The Ochres.—These substances are "hydrates of iron," which signifies, that they are composed of water and oxide of iron, mixed in various proportions, and sometimes closely combined with various sorts of earth.

The greater the proportion of clay, the brighter will be the color: when there is a portion of clay, the substance feels greasy to the touch, and has more body than those have which are mixed with chalk and silex.

The yellow ochres become red by calcination: the brown ochres, when pure, produce the finest red.

The "ochre of ru," which is incorrectly spelled and pronounced "rue," takes its etymology from the old word *ru* (ruisseau), a rivulet or brook, probably because that this ochre was found deposited in places formed in brooks of ferruginous waters.

Exposed to the fire, this substance takes a reddish brown color, not so brilliant, as that of the oxide of iron. This fact proves that it contains some remains of vegetable substances, or bituminous matter.

Terra di Sienna is a brown ochre, which, by calcination, produces only a moderately strong red. This proves that it must contain substances which prevent the development of the violet color, which belongs to the oxide of iron in its pure state.

Ochres may be prepared artificially, by moistening the rust of iron, and precipitating by the alkalis, solutions of this metal. For instance, in precipitating it by the sub-carbonate of soda, or of muriate of potass, of nitrate, of acetate of iron, or persulphate of iron, the most brilliant brown ochres are obtained. If the sulphate of iron is of a low oxidation, the precipitate is olive-colored, but it soon becomes yellow at the surface by absorbing a greater quantity of oxygen. To extend this operation to all the precipitates, it only requires exposure to the air, by stirring it up for a sufficient time. The same thing may be obtained in winter quite easily, by exposing it to the action of frost in wide shallow pans: the water passing into the state of ice, leaves a small quantity of air disengaged, which unites with the precipitate, and is sufficient to give it an even yellow tone.

When bright ochres are required, it will be necessary to mix alum, in certain proportion, with sulphate of iron; the solution is then to be precipitated by lime water. There exist in the natural state ochres of so very fine a quality, that they require no other preparation than that of being washed: therefore it is scarcely worth while to manufacture them artificially.

The permanency of these colors is proved by the state of the old pictures. In a box of colors found at Pompeii, and analysed by M. Count Chaptal, he discovered yellow ochre purified by washing, which had preserved its original brightness.

Orpiment.—This color was known in ancient times; the Latins called it auripigmentum, (gold color,) whence, by corruption, its present name is derived. It is a sulphuret of arsenic, found perfectly formed in a natural state: it is also prepared by artificial means.

There are two kinds of sulphuret of arsenic, the results of different proportions of these substances in combination. If the sulphur should predominate, the product will be a clear and very brilliant yellow; but should the arsenic predominate, the color will be orange; and it is then called "red orpiment," or "realgar."

Both these species have been in use from the earliest times of painting; and it is easy to perceive that this color must not be mixed with white lead, nor with any of those colors into which lead enters, such as massicot, minium, muriate and chromate of lead, and Naples yellow.

The sulphur in combination with the arsenic, having less affinity with this metal than for lead, lets it go, and forms a sulphuret of lead of a dark greyish color. But orpiment may be employed alone, or with ochres, and other colors that do not act upon them, as terre verte and ultramarine. There is little doubt but that the brilliant yellows, which we see in some ancient pictures, are preparations of orpiment.

Red orpiment, as we shall show in its place, is not so permanent as the yellow sort.

Sulphuret of Cadmium.—Chemists who have prepared this color say that it does not change. I am not, however, aware whether it has been used in combination with white lead. I fear that in such a case the sulphur would quit the cadmium, to unite with the lead. If that should not happen, this would be a most useful discovery. It is to be regretted that at present cadmium is scarce; but it is to be hoped, that as chromate of iron has been discovered, we shall be equally fortunate with respect to this article.

We are assured that the sulphuret of cadmium is used in Germany; and it is to be had in Paris amongst the principal manufacturing chemists.

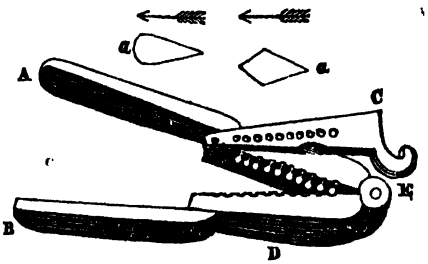
(To be continued.)

MANUFACTURE OF MARBLES, BULLETS, AND SHOT.

Large quantities of lead are used in this country in the manufacture of shot and bullets, so distinguished as the spherical masses are small or large. There are three convenient methods of producing shot—rolling, casting, and granulation: the first is but little resorted to in the sense here intended; the second operation is that by means of which the most perfect bullets are generally obtained; and the third, is that by which the shot of commerce is produced. If lead be drawn out into square strips or wire, and then be cut up, by means of a knife, or by any other instrument, into little cubical sections, these may be placed, several scores together, between two flat stones, the undermost one lying firm, and the upper one admitting of being moved about in every direction, and thus rolled into perfect shot. To secure exact sphericity, the stone must be moved in a sort of epicycloidal curve; for if it be advanced in right lines, or were merely spun round, the shot would have a cylindrical figure: iron plates, or polished stones, may be used to give to the shot a smoother and brighter appearance. It is in the above method that boys' marbles are made; and considering with what truth they are turned out of hand, it will show that the method is not to be condemned, except for its greater tediousness. It was by a method analogous to the foregoing, that small shot was originally manufactured: cubes of lead may likewise have an imperfect spherical form given to them by shaking them together. We recollect this method being once turned to ingenious account by two country forgemen, who were in the habit of shooting great numbers of the wild ducks which frequented the mill dam: the men used, in the first place, to cut up the lead into angular bits of the desired size; these they put into an oblong can of sheet-iron, which they fastened to the edge of the forge hammer; the latter, by its motion, violently shook the contents of the can up and down, until the bits within, striking against each other in every direction, soon became a very efficient, though not very handsome, sort of duck shot.

Pistol bullets and rifle balls, requiring to be of exact size, are generally cast in moulds, one at a time: swan shot, and other like sorts, are cast in a similar manner, but several together.

The annexed cut represents a pair of moulds for casting swan shot. They consist of two sides,

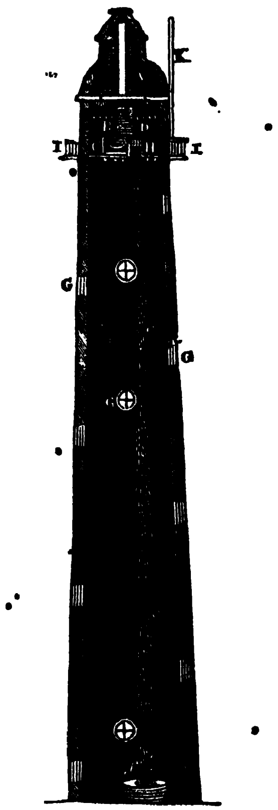


A B, about ten inches long each, made of brass, and joined by a pin at the end, much in the manner of a pair of common nut-cracks; in the faces of the upper parts, which are made to close very exactly, corresponding hermispherical cavities are formed, having each a little outlet to the edge. When the moulds are closed for casting, the steel plate C is brought over the face until it rests against a pin at D; its row of counter-sunk perforations exactly lying over the holes in the sides. Melted lead is now poured into each hollow through the apertures in the plate; after which, by striking or pressing it on the part at E, the castables, or tails, of the shot are cut off, and the shot taken out of the mould.

Notwithstanding the generally received opinion, that one principal feature of perfection in a bullet is sphericity, Mr. J. W. Boswell, in an ingenious communication to the Repertory of Arts, recommends the use of balls of the foregoing figures, Fig. *a*, *a* as better adapted to move in a straight line through the air, than those of a globular form, and which necessarily assume a rotatory motion in their progress through the barrel of the piece, and consequently take a bias in their projectile direction, determined by their friction against the right hand side, the left hand side, or the bottom of the barrel. The writer of the paper referred to, and whose theoretical observations are too long for quotation, says, "I never, before these experiments, practised shooting at a mark; and yet, with these bullets, from a common pistol, I have often hit a mark six inches square, at fourteen yards' distance, in the proportion of seven times out of twelve shots, while I could not, at the same time, with common balls, from the same pistol, hit it oftener than once in ten times." Any gentleman disposed to try bullets of these forms, might easily cast a few for experiment from well-dried plaster of Paris moulds, if brass ones could not be easily obtained.

The smaller sorts of shot are manufactured in a very perfect manner by granulation, or pouring the metal from a considerable height, in consequence of which it separates into globular masses of different sizes, which cool into that form during their descent, and which cooling is completed by their falling into water. One of the earliest successful practisers of this method was an individual at Bristol, of the name of Watts, a plumber, who, in 1782, obtained a patent for "arsenated shot;" the material of which consisted of soft pig lead saturated with white or yellow arsenic, in the proportion of about forty pounds of the latter to twenty hundred weight of the former. To effect the mixture, the lead, along with the arsenic, was put into an iron pot closely covered, and then heated to redness; this poisoned lead was not used alone, but mixed in various pro-

portions with that intended for the making of shot. The patent right having long since expired, most of the shot now seen is made of lead having in it some portion of arsenic, by which its sphericity and solidity are improved. To obviate objections which some have made against the arsenated material, a small quantity of quicksilver has been mixed with the lead, and which answers the purpose sufficiently. The following account has been given of the invention of the patent shot by Watts. In consequence of a dream, the idea was conceived of pouring melted lead through a considerable space; and the experiment was tried from the tower of the church of St. Mary Redcliffe, the church immortalised by Chatterton the poet Watts is said to have sold his patent to the eminent house of Walkers, Maltby, Parker, and Co. for £10,000. With this sum, he proposed to build a crescent at Clifton: the situation chosen was a huge rock, and the whole sum was expended in making excavations, and in raising immense walls for foundations, which long bore the name of Watts's Folly, and upon which walls Trafalgar Place was afterwards erected.



The specification of the patent obtained by the firm above named is inserted in the third volume of the Repertory of Arts, from which work it is here transcribed, along with the accompanying vertical section, of the kind of building commonly used in the manufacture of shot. Most visiters to London have noticed the shot towers on the banks of the Thames: these are on the south side of the river; their height is about 150 feet, affording a fall of about 130 feet for the shot. The alloy is described, in the specification, as consisting of forty pounds of arsenic to a ton of lead, prepared as above stated, and cast into pigs to be ready for use. By means of a suitable tackle and chain,—a part only of which, to prevent confusion in the drawing, is brought into view at *a a*,—ten pigs, of about 1½ cwt. each, are drawn up through a trap-door into the melting-room at the top of the tower; here the pigs are successively put into the cauldron *b*, which is heated by a common furnace, *c*, beneath, having a brick flue and chimney, terminated by an iron funnel reaching to the top of the upper dome, or lantern. When the alloy is melted, and the scoria properly formed, a portion of the latter is ladled by the melter into a kind of square colander, *d*, supported in an iron frame fixed close to the furnace; this vessel is twelve or fourteen inches square; it has a handle like a frying pan, and its bottom is perforated with circular holes, of a size suited to the shot about to be made. The quantity of dross required being determined by the experiment of making a few shot (which are not suffered to descend below the floor of the melting-room), a man now ladles the fluid metal out of the cauldron into the perforated vessel; in running through which it is somewhat detained and cooled in passing the scoria, which tends to separate it in small portions, where it collects underneath the colander at every hole in small globules, which instantly drop, and are followed by other globules, in such rapid succession as to appear at a little distance like a pouring rain of liquid silver. This metallic shower is represented in the cut *e e e*, and falls into a large tub of water, *f*, placed underneath. From the great specific gravity of the shot, they do not scatter in their descent; and the workmen cross the bottom floor of the tower, as their business requires, in perfect security.

The tower is quadrangular, and has four or five windows on each side, represented at *g g*; *h h* represent doorways, the upper one leading into an external gallery *i i*, which, as may be supposed, commands an extensive and highly interesting view of London and its suburbs; *k* is the stem of a long flag-staff. The staircase, from the bottom to the top of the tower, is of iron, and of great stability; it is represented, of course, as dissected in the engraving; the foot plates are of cast-iron, slightly fluted, to prevent slipping; and there are square landing-places at each corner of the quadrangle, as well as seats for the convenience of the weary or lazy ascendants and descendants. There are two or three other towers similar in their arrangements, but circular, at no great distance from the one here described. There is a round and lofty shot tower near Newcastle-upon-Tyne, from the balcony of which the spectator commands an interesting range of prospect, including the river with its vast assemblage of colliers and other craft.

The various sizes of the shot are distinguished, by the manufacturers, by the Nos. 1 to 12: the largest, No. 1, are called swan shot; the smallest, No. 12, dust shot; their diameter varying from one-thirtieth to one-fourth of an inch. The shot, when removed out of the tub, are dried by artificial heat, as they remain considerably wet, by the water being held between the little spheres by capillary attraction; to dry them, they are scattered over a large heated iron-plate, having a furnace beneath, on which they are well stirred about, and swept off as soon as dry. After this operation, they present a dead white silvery appearance: they contain amongst them many

(though but a small proportion) of imperfect shot, and the perfect differ somewhat in size: to separate these varieties from one another constitutes the next process. The dried shot are, therefore, taken to the sifters, who have each the management of a series of three or four sieves placed in a row, in a reciprocating iron frame, which derives its motion from a steam-engine: the movement is effected by a horizontal revolving shaft (near the ceiling of the room), having at the extremity a short crank, from which depends a rod that is made to rise up and down; this vertical rod is attached at its lower extremity to a lever of the common bell-crank kind, which is connected to the frame containing the sieves, and, therefore, produces in the latter a reciprocating horizontal motion. Each sieve is also provided with a distinct frame embracing its circumference, with a large joint on one side, which connects it to the general frame. A quantity of the shot being thrown into the first sieve, that portion of them which is small enough passes through its meshes; the rest, that are too large, are then discharged into the next sieve, by *turning over* the first on its hinge joint, as a person would open and throw back the lid of a box. The advantage of this arrangement will be evident, when it is considered that the sieves, being constantly in rapid motion, it would be no easy matter to throw the shot from one into the other, were they separate, without spilling; whereas, by their connection, the shot cannot be discharged otherwise than as intended. The attendant on the sifting apparatus has, therefore, only to supply the first sieve, and to discharge the contents from one to the other successively. The produce of the two first sieves is collected into separate bins; and, as these contain many shot of imperfect *forms*, they are taken thence to another set of operators, who separate the bad from the good, by a process equally simple and effectual. Those which have not passed through the two first sieves of the series are condemned as bad, and are remelted.

A number of shallow quadrangular trays, the figure of which may be defined by the boundary line of a plane, produced by the longitudinal section of the frustrum of a cone in the line of its axis, made of hard wood, and perfectly smooth at the bottom, are suspended from the ceiling by cords attached to the two corners of the widest ends of the trays, their other, or narrowest ends, resting upon the edges of a row of shot-bins. Thus arranged, a boy, who manages two of these trays, throws upon each at the widest end (that nearest to him) a small measure-full of shot; he then takes hold of the trays, and, giving them a gentle vibrating motion laterally, and at the same time raising the ends a little, to give them a slight inclination, the shot roll about, tending from side to side, those that are perfectly spherical making their way quickly off the boards into the bin at the extremity; while those which are imperfect are detained by their comparatively sluggish movements; and, being thus separated from the good, the trays are pushed forward about a foot, and their contents emptied into other bins placed beyond those containing the good shot as before mentioned. This operation is so effectual, that it is difficult to pick an imperfect shot out of those that come to market. Four or five boys thus employed, with two trays to each, suffice for a manufactory of the kind above described, which makes about five tons per day. The smallest shot require the utmost care and gentlest management of the inclined plane; therefore the eldest or steadiest hands are selected to operate upon them. The next and last part of the business, previous to the shot being bagged for the market, is to polish them; for this purpose a cast-iron barrel, holding, perhaps, half a ton weight, is nearly filled with them, and a rotary movement communicated to it by the engine, which causes all the little spheres to rub against each other, and gives them a black lustre, materially differing from their previous argentine complexion. It is remarked that a curious effect is produced upon the interior of the cast-iron barrel by the friction of the shot,—that of wearing it into a regular series of grooves; so that a stranger would suppose the barrel had been cast with an internal fluting.

JAPANNING TUNBRIDGE-WARE.

BY A TUNBRIDGE-WARE MANUFACTURER.

(Resumed from page 103, and concluded.)

It is rather difficult to explain by words the finishing process in Tunbridge-ware, as under different circumstances and weather, &c. the time required for drying, &c. varies very much, and any person trying it must use their own judgment, according to the nature of the article, and the polish required to ensure success. After the article is ornamented or painted it must have a square block of wood according to its size, and from 4 to 6 inches long, glued slightly on the bottom, to serve as a handle in the future process. It must then receive from six to eight coats of spirit varnish, this should occupy two days; let it remain the following night in the varnish room, that it may set gradually, and then remove it to an airy place; the more current of air, providing neither damp nor sun can get at it, the better; let it remain here about a fortnight, if you wish your work to stand well. When quite hard the varnish will crack all over in very minute cracks.

The next process is technically called *rubbing down*—to do this provide yourself with some very finely grated chalk, perfectly free from grit, and a rubber made of *stuff* doubled flat five or six times round a piece of very stiff pasteboard, also a pan of clean water; stop up the key-hole with tallow or bees'-wax, and fixing the article by the block in screws, or any way convenient, soak the rubber in water, then, while wet, cover it with the grated chalk dry, and with it rub the article too and fro, and afterwards crossways, till the cracks are all removed, and the surface is perfectly flat and even, continually dipping your rubber in the water, and taking fresh dry chalk, but keeping your rubber wet, and your hands also, to prevent the varnish printing—wipe off occasionally with the palm of your hand to observe the progress, and prevent rubbing through. Be careful not to touch it with your hands dry, as the rubbing softens the varnish; when smooth and even all over stand by for about a week—it will then be ready for polishing. This is done in the same way as the rubbing down with dry chalk and water, only using a woollen cloth rubber, instead of the stuff one, and less chalk, and the finishing or smoothing is done with the palm of the hand wet, without any rubber at all. When the required polish or brightness is obtained, which takes but very little time, as it is supposed to be perfectly flat, smooth, and even, from the rubbing down, and the polishing is only to give a brightness

to the surface by a delicate and very slight friction on the varnish, now thoroughly hard and even. Stand it by till the next day, then unstop the key-hole, knock off the block, scrape any of the unvarnished parts where the chalk and water may have soaked in. Line the inside with silk, satin, velvet, tinfoil, or paper, according to the nature of the article. Then oil all over the polished parts with a piece of flannel, soaked in Florence oil; and finally, clean and finish off with a very soft cotton or silk duster, and common flour; dry, and if well done, it will look almost like plate glass. This is the process for the best articles, which can be much shortened for common purposes; and every person who feels at all interested, and makes a trial, will soon obtain a practical knowledge of the process, and be able to finish the articles according to their quality—always minding the longer the time allowed for drying and cracking, the more durable the work when finished. Inlaid fancy wood, Mosaic Tunbridge-ware is finished in the same way; but plain veneered work is usually French polished, which is quite a different process.—Your's, &c.

UEZO.

NEBULÆ.

Multitudes of nebulous spots are to be seen on the clear vault of heaven, which have every appearance of being clusters of stars, but are too distant to be resolved by the most excellent telescopes. Vast numbers also appear to be matter in the highest possible degree of rarefaction, giving no indication whatever of a stellar nature. These are in every state of condensation, from a vague film hardly to be discerned with telescopes of the highest powers, to such as seem to have actually arrived at a solid nucleus. This nebulous matter exists in vast abundance in space. No fewer than 2000 nebulæ and clusters of stars were observed by Sir William Herschel, whose places have been computed from his observations, reduced to a common epoch, and arranged into a catalogue in order of right ascension by his sister, Miss Caroline Herschel, a lady so eminent for astronomical knowledge and discovery. Six or seven hundred nebulæ have already been ascertained in the southern hemisphere; of these the Magellanic clouds are the most remarkable. The nature and use of this matter, scattered over the heavens in such a variety of forms, is involved in the greatest obscurity. That it is a self-luminous, phosphorescent, material substance, in a highly dilated or gaseous state, but gradually subsiding by the mutual gravitation of its particles into stars and sidereal systems, is the hypothesis most generally received. And, indeed, this is the hypothesis of La Place with regard to the origin of the solar system, which he conceived to be formed by the successive condensations of a nebula, whose primeval rotation is still maintained in the rotation and revolution of the sun, and all the bodies of the solar system in the same direction. But the only way that any real knowledge on this mysterious subject can be obtained is by the determination of the form, place, and present state of each individual nebula; and a comparison of these with future observations will show generations to come the changes that may now be going on in these supposed rudiments of future systems. With this view, Sir John Herschel began in the year 1825 the arduous and pious task of revising his illustrious father's observations, which he finished a short time before he sailed for the Cape of Good Hope, in order to disclose the mysteries of the southern hemisphere: indeed, our firmament seems to be exhausted till farther improvements in the telescope shall enable astronomers to penetrate deeper into space. In a truly splendid paper read before the Royal Society on the 21st of November, 1833, he gives the places of 2500 nebulæ and clusters of stars. Of these 500 are new,—the rest he mentions with peculiar pleasure as having been most accurately determined by his father. This work is the more extraordinary, as, from bad weather, fogs, twilight, and moonlight, these shadowy appearances are not visible, on an average, above thirty nights in the year.

The nebulæ have great variety of forms. Vast multitudes are so faint as to be with difficulty discerned at all till they have been for some time in the field of the telescope, or are just about to quit it. Occasionally they are so vague that the eye is conscious of something, without being able to define what it is; but the unchangeableness of its position proves that it is a real object. Many present a large ill-defined surface, in which it is difficult to say where the centre of the greatest brightness is. Some cling to stars like wisps of cloud; others exhibit the wonderful appearance of an enormous flat ring seen very obliquely, with a lenticular vacancy in the centre. A very remarkable instance of an annular nebula is to be seen exactly half-way between β and γ Lyræ. It is elliptical in the ratio of 4 to 5, is sharply defined, the internal opening occupying about half the diameter. This opening is not entirely dark, but filled up with a faint hazy light, aptly compared by Sir John Herschel to fine gauze stretched over a hoop. There is a very remarkable nebula in Orion, and there is some reason to believe that a new star has appeared in it recently. Two nebulæ are described as most amazing objects:—One like a dumb-bell or hour-glass of bright matter, surrounded by a thin hazy atmosphere, so as to give the whole an oval form, or the appearance of an oblate spheroid. This phenomenon bears no resemblance to any known object. The other consists of a bright round nucleus, surrounded at a distance by a nebulous ring split through half its circumference, and having the split portions separated at an angle of 45° each to the plane of the other. This nebula bears a strong similitude to the milky way, and suggested to Sir John Herschel the idea of a "brother system bearing a real physical resemblance and strong analogy of structure to our own." It appears that double nebulæ are not unfrequent, exhibiting all the varieties of distance, position, and relative brightness with their counterparts the double stars. The rarity of single nebulæ as large, faint, and as little condensed in the centre as these, makes it extremely improbable that two such bodies should be accidentally so near as to touch, and often in part to overlap each other as these do. It is much more likely that they constitute systems; and if so, it will form an interesting subject of future inquiry to discover whether they possess orbitual motion.

Stellar nebulæ form another class. These have a round or oval shape, increasing in density towards the centre. Sometimes the matter is so rapidly condensed as to give the whole the appearance of a star with a blur, or like a candle shining through horn. In some instances the central matter is so highly and suddenly condensed, so vivid and sharply

defined, that the nebula might be taken for a bright star surrounded by a thin atmosphere. Such are nebulous stars. The zodiacal light, or lenticular-shaped atmosphere of the sun, which may be seen extending beyond the orbits of Mercury and Venus soon after sunset in the months of April and May, is supposed to be a condensation of the ethereal medium by his attractive force, and seems to place our sun among the class of stellar nebulæ. The stellar nebulæ and nebulous stars assume all degrees of ellipticity. Not unfrequently they are long and narrow, like a spindle-shaped ray, with a bright nucleus in the centre. The last class mentioned by Sir John Herschel are the planetary nebulæ. These bodies have exactly the appearance of planets, with sensibly round or oval discs, sometimes sharply terminated, at other times hazy and ill defined. Their surface, which is blue or bluish-white, is equable or slightly mottled, and their light occasionally rivals that of the planets in vividness. They are generally attended by minute stars, which give the idea of accompanying satellites. These nebulæ are of enormous dimensions. One of them, near ν Aquarii, has a sensible diameter of about 20″, and another presents a diameter of 12″. Sir John Herschel has computed that, if these objects be as far from us as the stars, their real magnitude, on the lowest estimation, must be such as would fill the orbit of Uranus. He concludes that, if they be solid bodies of a solar nature, their intrinsic splendour must be greatly inferior to that of the sun, because a circular portion of the sun's disc, subtending an angle of 20″, would give a light equal to that of a hundred full moons; while, on the contrary, the objects in question are hardly, if at all, visible to the naked eye. From the uniformity of the discs of the planetary nebulæ, and their want of apparent condensation, he presumes that they may be hollow shells, only emitting light from their surfaces.

The existence of every degree of ellipticity in the nebulæ—from long lenticular rays to the exact circular form,—and of every shade of central condensation—from the slightest increase of density to apparently a solid nucleus,—may be accounted for by supposing the general constitution of these nebulæ to be that of oblate spheroidal masses of every degree of flatness, from the sphere to the disc, and of every variety in their density and ellipticity towards the centre. It would be erroneous, however, to imagine that the forms of these systems are maintained by forces identical with those already described, which determine the form of a fluid mass in rotation; because, if the nebulæ be only clusters of separate stars, as in the greater number of cases there is every reason to believe them to be, no pressure can be propagated through them. Consequently, since no general rotation of such a system as one mass can be supposed, it may be conceived to be a quiescent form, comprising within its limits an indefinite multitude of stars, each of which may be moving in an orbit about the common centre of the whole, in virtue of a law of internal gravitation resulting from the compound gravitation of all its parts. Sir John Herschel has proved that the existence of such a system is not inconsistent with the law of gravitation under certain conditions.

The distribution of the nebulæ over the heavens is even more irregular than that of the stars. In some places they are so crowded together as scarcely to allow one to pass through the field of the telescope before another appears, while in other parts hours elapse without a single nebula occurring. They are in general only to be seen with the very best telescopes, and are most abundant in a zone whose general direction is not far from the hour circles 0h and 12h, and which crosses the milky way nearly at right angles. Where that zone crosses the constellations Virgo, Coma Berenices, and the Great Bear, they are to be found in multitudes.

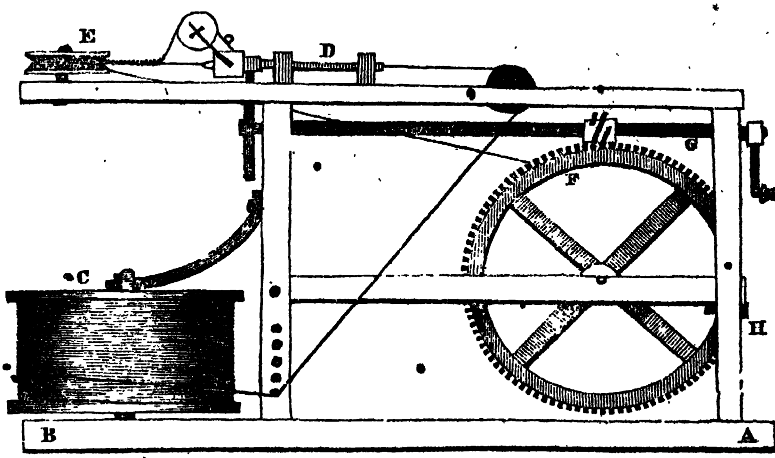
Such is a brief account of the discoveries contained in Sir John Herschel's paper, which, for sublimity of views and patient investigation, has not been surpassed. To him and Sir William Herschel we owe almost all that is known of sidereal astronomy; and in the inimitable works of that highly gifted father and son, the reader will find this subject treated of in a style altogether worthy of it, and of them.

MISCELLANIES.

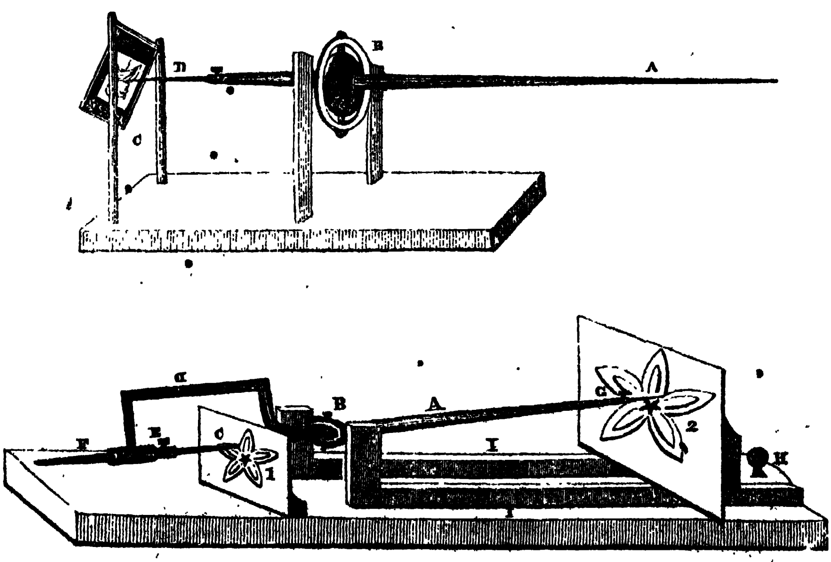
Spontaneous Combustion.—Mr. Marsh, chemist, connected with the Royal Arsenal, recently discovered that it is an invariable rule with iron which has remained for a considerable time under water, when reduced to small grains, or to an impalpable powder, to become red-hot, and to ignite any object with which it may come in contact. This he experienced by scraping some corroded metal from a gun, which ignited the paper containing it, and burnt a hole in his pocket. The knowledge of this fact may be useful in accounting for spontaneous fires, the origin of which has never been traced.

Gilding of Metals by Electro-Chemical Action.—M. de la Rive has succeeded in gilding metals by means of this powerful action. His method is as follows:—He pours a solution of chloride of gold, (obtained by dissolving gold in a mixture of nitric and muriatic acid,) as neutral as possible and very dilute, into a cylindrical bag made of bladder; he then plunges the bag into a glass vessel containing very slightly acidulated water. The metal to be gilded is immersed in the solution of gold, and communicates by means of metallic wire with a plate of zinc, which is placed in the acidulated water. The process may be varied, if the operator pleases, by placing the acidulated water and zinc in the bag, and the solution of gold with the metal to be gilded on the glass vessel. In the course of about a minute, the metal may be withdrawn, and wiped with a piece of linen; when rubbed briskly with the cloth it will be found to be slightly gilded. After two or three similar immersions the gilding will be sufficiently thick to enable the operator to terminate the process.—*Athenæum.* [Platinizing the silver plates used in Mr. Grove's and Smee's batteries are always now done in the above method. Silvering of articles of various kinds is equally easy. M. de Rive is not entitled to the application, as it is a necessary consequence of Mr. Spencer's discovery.—Ed.]

The Changeable Rose.—Take a common full-blown red rose, and having thrown a little sulphur finely pounded into a chaffing-dish with coals, expose the rose to the vapour. By this process the rose will become whitish; but if it be afterwards immersed some time in water, it will resume its former color.



WAGSTAFF'S WIRE COVERING MACHINE.



TRACING AND PROFILE INSTRUMENTS.

WIRE COVERING MACHINE.

To the Editor.

SIR.—As the covering of wire with cotton, &c., is at present a matter of importance to the scientific, and as the machines in general are not to the purpose of the person who wishes to cover a small quantity for his own use, I send you a description of a machine for that purpose, the expense of making which is but a trifle. The wire to be covered may be of any reasonable length—the manner in which it is covered is inferior to none, and the entire machine may be tied up in a handkerchief. By publishing which you would oblige, P. WAGSTAFF.

Wood Street, Chorlton-on-Medlock, Manchester.

A B is a stand, 1 foot long, 9 inches wide, in which are four uprights, 7 inches high, with cross pieces both ways at top. The wire to be covered is wound on the cylinder C—the end is brought under a peg at the side of the machine, from thence over the pulley at top, and through the tube D, which is fixed in two uprights. It then passes, (after being covered,) round the horizontal pulley E, and is drawn off by the drum F, which is 5 inches long, in the form of a sugar loaf, 4 inches at one end, and 4½ at the other. The shaft G is turned by the handle—the worm is fixed on it, and works in a wheel of 80 teeth, fixed on the wide end of the drum F. At the end of the shaft is a wheel of 60 teeth, turning a pinion which consists of 12 wires, fixed in the end of a piece of wood, which is centered on the end of the tube D, and carries round the bobbin of cotton, which turns on a wire put through two others fixed in the piece of wood, in which is also forced a spring—the other end pressing on the bobbin to give tension to the cotton. The wire is likewise tightened by a spring fixed to one of the uprights, and pressing on the cylinder C. The handle being turned, it causes the bobbin to revolve round the wire while the drum draws the wire regularly off. The cotton used may be No. 30, wound four-fold. If the wire be rather short of covering, shift it a little towards the small end of the drum, where it will be drawn off slower, and the contrary. When a sufficient quantity of wire has accumulated in one place, it is shifted to the small end of the drum, and the operation continued. When the covering is complete, the wedge H is taken out, the wheel sinks below the worm, and the wire may thus be wound off.

PROFILE, OR SILHOUETTE INSTRUMENT.

THE instrument by which profiles are taken is of the simplest possible construction, and although, if applicable to this purpose only, it would be of little value, yet as tracings of the outlines of models of all kinds, patterns, furniture, &c. &c., may be laid down with equal facility, with unerring correctness, and of any required size, the instrument becomes of importance. In fact, were it more generally adopted for such purposes much time would often be saved to the draughtsman; and he who is ignorant of the art of drawing would be enabled very often to transmit to paper a faithful outline. Besides which it may be remarked, that the whole cost is but a trifle, and any person may make the instrument himself, or by the aid of an ordinary mechanic.

Fig. 2 represents the profile instrument. A is a long, thin, straight wire or wooden rod. B shows a ring or gymbal, supported on an axis at its two sides, and having a hole at top and bottom, through each of which holes passes a pin, serving as an axis to a ball withinside the ring. This ball has a hole through its axis, in which the rod A passes freely, so as to be capable of being pushed more and more through as occasion may require—being held in its position by a screw, through one of the sides of the ball, pressing against it. D is the same rod as A, but continued through the ball, and bearing a pencil at its extremity. C consists of two upright arms, supporting a small flap, which swings at the top. Upon the flap is placed the piece of paper upon which the object is to be delineated, and the reason of this swinging is, that it may always press in a slight degree against the pencil point. This flap, with its two uprights, should in truth slide backwards and forwards on the stand at bottom, that it may be adjusted to the pencil, for it will be seen that the cut only shows it as adapted to a certain length of D. To use the instrument, nothing more is necessary than to furnish the flap at C with a piece of paper—to furnish D with a pencil—adjust the distance of the flap, and pass the end of the rod A over the features of a person sitting behind it. The relative size of the real object and its representation will depend upon the length of A, compared to the length of D, reckoning each from the point to the ball, and the only use of the rod sliding in the socket is to regulate these proportionate lengths, and consequently sizes of the two. The rod, it will be seen, is free to move in every direction, by means of its double suspension—the pins top and bottom, upon which it immediately turns, give it motion sideways, while the bearings of the gymbal upon the two side bearers allow of an equally free movement up and down.

To make the above instrument, the arms A and D should be of considerable length, 10 or 12 feet together at least, because each end moves in a circle, and a true depicting of the object is only really at the centre, deviating from this ever so little occasions a certain degree of distortion. When the arms are long, the distortion is not perceptible, but when short it is very disagreeable. The longer therefore that the arms are made the better.

BALDRENCE'S TRACING INSTRUMENT.

THIS is but a modification of the last, but will be acknowledged as a great improvement upon it. It was invented chiefly for the purpose of transferring and altering the size of shawl and other patterns for the use of the weaver. Fig. 3 is a representation of the instrument, and the construction of it is so similar to that of the Profile Machine, that it seems scarcely necessary to repeat it. The card, No. 1, is the design as traced by the pointer or pencil, C. The card, No. 2, is the original design to copy from—it is passed over by G. A is the long rod as before. B its support. D a bent arm of the shorter lever. F a metal rod, capable of motion backwards and forwards in a socket of D. E is a screw to hold the pencil tightly. I I are two ribs between which slides the stand, holding the card, No. 2, and which is kept close to the point G, either by means of a cord and weight, passing from the front of it along the instrument, and finally over a little pulley, and through the lower stand beneath—the weight pulling the card, No. 2, so as to be always up to its work, or else by a spring at the back of it at H.

PRINTING INK.

After reviewing the different prescriptions given by Moxon, Breton, Papillon, Lewis, those in Nicholson's, and the Messrs. Aikins' Dictionaries, in Rees' Cyclopædia, and in the French Printer's Manual, Mr. Savage says, in his work on the "Preparation of Inks," that the Encyclopædia Britannica is the only work, to his knowledge, which has given a recipe by which a printing ink might be made, that could be used, though it would be of inferior quality, as acknowledged by the editor; for it specifies neither the qualities of the materials, nor their due proportions. The fine black ink made by Mr. Savage, has, he informs us, been pronounced by some of our first printers to be unrivalled; and has procured for him the large medal from the Society for the Encouragement of Arts.

1. *Linseed oil.*—Mr. S. says, that the linseed oil, however long boiled, unless set fire to, cannot be brought into a proper state for forming printing ink; and that the flame may be most readily extinguished by the application of a pretty tight cover to the top of the boiler, which should never be more than half full. The French prefer nut oil to linseed; but if the latter be old, it is fully as good, and much cheaper, in this country at least.

2. *Black rosin* is an important article in the composition of good ink; as by melting it in the oil, when that ingredient is sufficiently boiled and burnt, the two combine, and form a compound approximating to a natural balsam, like that of Canada, which is itself one of the best varnishes that can be used for printing ink.

3. *Soap.*—This is a most important ingredient in printer's ink, which is not even mentioned in any of the recipes prior to that in the Encyclopædia Britannica. For want of soap, ink accumulates upon the face of the types, so as completely to clog them up after comparatively few impressions have been taken; it will not wash off without alkaline lyes, and it skins over very soon in the pot. Yellow rosin soap is the best for black inks; for those of light and delicate shades, white curd soap is preferable. Too much soap is apt to render the impression irregular, and to prevent the ink from drying quickly. The proper proportion has been hit, when the ink works clean, without clogging the surface of the types.

4. *Lamp black.*—The vegetable lamp black, sold in firkins, takes by far the most varnish, and answers for making the best ink.

5. *Ivory black* is too heavy to be used alone as a pigment for printing ink; but it may be added with advantage by grinding a little of it upon a muller with the lamp black, for certain purposes; for instance, if an engraving on wood is required to be printed so as to produce the best possible effect.

6. *Indigo* alone, or with an equal weight of Prussian blue, added in small proportion, takes off the brown tone of certain lamp-black inks. Mr. Savage recommends a little Indian red to be ground in with the indigo and Prussian blue, to give a rich tone to the black ink.

7. *Balsam of capivi*, as sold by Mr. Allen, Plough Court, Lombard Street, mixed, by a stone and a muller, with a due proportion of soap and pigment, forms an extemporaneous ink, which the printer may employ very advantageously when he wishes to execute a job in a peculiarly neat manner. Canada balsam does not answer quite so well.

After the smoke begins to rise from the boiling oil, a bit of burning paper stuck in the cleft end of a long stick, should be applied to the surface, to set it on fire, as soon as the vapour will burn; and the flame should be allowed to continue (the pot being meanwhile removed from over the fire, or the fire taken from under the pot,) till a sample of the varnish, cooled upon a pallet-knife, draws out into strings of about half an inch long between the fingers. To six quarts of linseed oil thus treated, six pounds of rosin should be gradually added, as soon as the froth of the ebullition has subsided. Whenever the rosin is dissolved, one pound and three quarters of dry brown soap, of the best quality, cut into slices, is to be introduced cautiously, for its water of combination causes a violent intumescence. Both the rosin and soap should be well stirred with the spatula. The pot is to be now set upon the fire, in order to complete the combination of all the constituents.

Put next of well ground indigo and Prussian blue, each 2½ ounces, into an earthen pan, sufficiently large to hold all the ink, along with 4 pounds of the best mineral lamp black, and 3½ pounds of good vegetable lamp black; then add the warm varnish by slow degrees, carefully stirring, to produce a perfect incorporation of all the ingredients. This mixture is next to be subjected to a mill, or slab and muller, till it be levigated into a smooth uniform paste.

One pound of a superfine printing ink may be made by the following recipe of Mr. Savage:—Balsam of capivi, 9 oz.; lamp black, 3 oz.; indigo and Prussian blue, together, p. æq. 1¼ oz.; Indian red, ¾ oz.; turpentine (yellow) soap, dry, 3 oz. This mixture is to be ground upon a slab, with a muller, to an impalpable smoothness. The pigments used for colored printing inks are, carmine, lakes, vermillion, red lead, Indian red, Venetian red, chrome yellow, chrome red or orange, burnt *terra di Sienna*, gall-stone, Roman ochre, yellow ochre, verdigris, blues and yellows mixed for greens, indigo, Prussian blue, Antwerp blue, lustre, umber, sepia, browns mixed with Venetian red, &c.

FUNDAMENTAL PRINCIPLE OF WHEEL-WORK.

In the construction of wheel-work considerable attention ought to be paid to the shape of the various parts, as much of the efficiency and permanency of the work depends on this.

The teeth should be so formed, as that,

1st. The teeth of one wheel should press in a direction perpendicular to the radius of the other wheel; or, in other words, the pressure should be *tangential* to the wheel which is driven.

2nd. As many teeth as possible should be in contact at the same time, in order to distribute the pressure amongst them, and thereby to diminish the pressure upon each tooth. This arrangement will diminish the wear, and the chances of fracture.

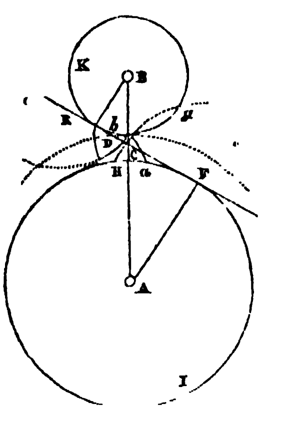
3rd. During the entire action of one tooth upon another, the direction of the pressure should be the same, in order that, acting with the same leverage, the effect may be uniform.

4th. The surfaces of the teeth in working should not rub one upon another, and should suffer no jolt either at the commencement or termination of their mutual contact.

Various forms have been suggested for the teeth, with a view to the accomplishment of some or all of these advantages; but that which seems best calculated to attain the desired ends is the following.

Suppose that F H I, Fig. 1, is the circumference of the wheel on which it is proposed to raise teeth, and let H be one of the points from which the side

Fig. 1.



of a tooth is to spring. Suppose a string is attached to the circumference of the wheel as at I, and applied to the circumference I F, and terminated at H, carrying a pencil at its extremity. Let the string, being constantly stretched, be rolled off, so that that part of it, F C, which has been disengaged from the circumference of the wheel, shall be in a straight line, touching the circumference at F, and in this way let the pencil describe the curve H C *g*. Let *a* H be the breadth of the tooth at the circumference of the wheel; and attaching a string in like manner to the other side of the wheel, and rolling it on in the opposite direction, so that its extremity bearing the pencil shall be at *a*, let a similar curve be described. These two curves will include a space which will represent the form of a tooth which will accomplish all the purposes, and possess all the advantages we have mentioned.

The teeth of the pinion, of course, are to be formed in the same manner.

It is a remarkable property of these curves, that a line F E which touches both circles will pass through the point of contact of the teeth, and not only of one pair of teeth, but of every pair which are in contact: and this line will be perpendicular to the direction of the surfaces of the teeth at the point of their mutual contact. Thus the pressure of the pinion on the wheel is exerted tangentially to both, and therefore acts always with the same leverage, and to the greatest advantage.

Further, during the whole period of the contact of any two teeth, the pressure acts in the same direction, and with the same force, and therefore when it is uniform, it necessarily produces an uniform effect.

During the motion, the surface of one tooth does not *rub* or *scrape* against the surface of the other, but the one *rolls* upon the other, thereby removing nearly all the effects of friction, and diminishing considerably the wear of the machinery, and the waste of the power.

Several teeth are in contact at the same time, and all working with equal power, so that the stress is equally distributed among them, and the chances of fracture are greatly diminished.

Thus this form of tooth has all the advantages which can be desired.

In regulating the number of teeth in the wheel, and the pinion which works it, it should be so contrived that the same teeth should be engaged as seldom as possible, in order to avoid inequality of wear. For example, let us suppose that the number of teeth in a wheel were exactly ten times the number of leaves in the pinion; each leaf in the pinion would engage every tenth tooth of the wheel, and would work inevitably on the same ten teeth every revolution of the wheel. If it were possible that all the teeth and leaves could be constructed with mathematical precision, and perfect and absolute similitude, and that no accidental difference, owing to any want of uniformity in the material of which they are formed, could exist, this would be a matter of no consequence, and the wear would still be even and equable. But as these perfections never can exist, the inevitable inequalities incident, as well to the nature of the material of which wheels are constructed, as to the forms they derive even from the most perfect mechanical construction, must be compensated by making the teeth and leaves work, so that each leaf shall successively engage with all the other teeth of the wheel, before it engages a second time with any one of them.

This is accomplished by making the number of teeth and the number of leaves *prime* to each other, that is, that no integer divides both exactly. The manner in which this is commonly done, is by making the number of teeth such, that it is just one more than a number which is exactly divisible by the number of leaves. This is what mill-wrights call making a *hunting cog*. Thus, suppose that there are ten leaves, and that the diameter of the wheel is about six times that of the pinion. If this were the exact ratio, there would be just sixty teeth, and after each revolution of the wheel the same teeth and leaves would be continually engaged, each leaf taking every sixth tooth. But if the diameter of the wheel be made somewhat greater than six times that of the pinion, so as to admit sixty-one teeth; then, after six revolutions of the pinion, the first leaf will be engaged with the tooth immediately before that in which it had worked at the commencement, and after six more revolutions it will be engaged with the tooth before that, or the second tooth from that at which the motion commenced. Thus, it is evident, that the wheel must revolve 61 times, and the pinion 6 × 61, or 366 times before the same teeth will be again engaged. By these means, the inequalities of wear arising from inequalities of form and material will compensate each other.

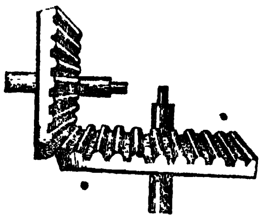
The teeth of the wheel, instead of working in the leaves of a pinion, are made to act upon a form of wheel called a *lantern*, as represented at

Fig. 2.

The cylindrical teeth or bars of the lantern are called *trundles* or *spindles*. However, notwithstanding the various forms of wheel-work, the principles which we have already explained will always determine the relation between the power and resistance.

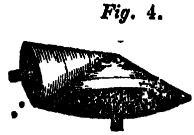
Wheels are denominated *spur*, *crown*, or *bevel gear*, according to the position or direction of the teeth. If the teeth be perpendicular to the axis of the wheel, and in the direction of radii, as in the wheel, Fig. 2, it is called a *spur-wheel*. If the teeth be parallel to the axis of the wheel, and therefore perpendicular to its plane, it is called a *crown-wheel*. Two spur-wheels, or a spur-wheel and pinion which work in one another, are always in the same plane, and have their axis parallel. But when a spur and crown-wheel are in connexion, their planes and axis are at right angles. By this means, therefore, rotatory motion may be transferred from a horizontal to a vertical plane, or *vice versâ*.

When the teeth are oblique to the plane or axis of the wheel, it is called a bevelled-wheel. Two wheels of this kind are represented in *Fig.* 3.



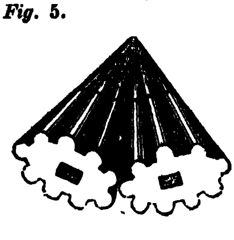
In this case, the surfaces on which the teeth are raised are parts of the surfaces of two cones. The manner in which these wheel act, and the principles on which their formation depends, may be conceived by imagining two cones to be applied side to side. If their surfaces have sufficient friction, and one of them be turned upon its axis by a mechanical force, it will compel the other to revolve; and if the bases of the cones be equal, each will revolve in the same time. But if the diameter of the base of one be equal to any number of times the diameter of the base of the other, then the lesser cone will revolve as many times in one revolution of the greater.

Fig. 4.



It is evident that what we have observed of the entire cones, will be equally true of any parts of them, equally distant from their common vertex, and therefore would be true of wheels, the edges of which are parts of the conical surfaces.

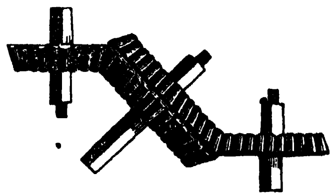
If the friction of the conical surfaces be insufficient to transmit the force, the surfaces may be fluted, as in *Fig.* 5.



and if the conical surfaces be incomplete, they will become *bevelled-wheels*.

It will be easily perceived that the use of bevelled wheels is to produce a rotatory motion round one axis by means of a rotatory motion round another which is oblique to it; and, provided that the two axes are in the same plane, this may always be accomplished by two bevelled-wheels. A system of wheels of this kind is represented in

Fig. 6.



PREPARING SKELETONS.

As much of the fleshy parts should be removed from bones intended for preparation as possible with the scalpel, but it is not required that they should be separated from each other, more than is necessary for placing them in a vessel for the purpose of maceration. The bones are to be entirely covered with water, which should be changed every day for about a week, or as long as it becomes discolored with blood; after which, allow them to remain in water without changing till putrefaction has thoroughly destroyed all the remaining flesh; this will require from three to six months, according to the season of the year or temperature of the atmosphere. We here speak of Great Britain, but in warmer climates putrefaction will take place more rapidly. In tropical climates, fourteen days will be sufficient to disengage the flesh completely from the bones.

The large cylindrical bones of the thighs and arms should have holes bored in their extremities of the size of a goose quill, to give the water access to their cavities, and a free exit to the medullary substance.

As the water will gradually diminish in quantity from evaporation, more should be added from time to time, so that none of the bones, or any part of them, may remain uncovered, as by exposure to the atmosphere they would become of a dirty color, and have a disagreeable appearance. To be free from such stains is considered a great beauty in skeletons.

In towns the macerating vessels should always be closely covered, as from neglecting this, the water is apt to get mixed with particles of soot, and other impurities, which have a strong tendency to blacken the bones. When the putrefaction has destroyed the ligaments, the bones are then fit for cleaning, which is done by scraping off the flesh, ligaments, and periosteum. When this is effected, the bones should be again laid in clean water for a few days, and well washed. They ought then to be placed in lime water, or a solution of pearl ash, for a week, when they may be taken out to dry, after having soaked them five or six hours in pure water, to remove the solution of pearl-ash, which would act upon their surface when exposed to the atmosphere.

In drying bones they should not be exposed to the rays of the sun, or to a fire, as too great a

degree of heat brings the remaining medullary oil into the compact substance of the bones, and gives them a disagreeable oily transparency. This is the great objection to the process of boiling bones, for the purpose of making skeletons, as the heat applied in that way has the same effect, unless they are boiled in a solution of pearl-ash, which some are of opinion is one of the most effectual methods of whitening them, by its effectually destroying the oil. But there can be but little doubt that bleaching is, of all methods, the most effectual where it can be done to its greatest advantage, namely, in a pure air, and more especially on a sea-shore.

It is much more difficult to clean the bones of animals that have died in good condition, than those that are lean and reduced by disease.

Natural Skeletons.—Natural skeletons are made without separating the bones from each other, in which case all the animal ligaments are allowed to remain entire. This plan is generally adopted with young and small animals, because the ligaments, when dry, being divested of their natural flexibility, occasion an inconvenience, as the different extents and varieties of motion cannot be shown in the different articulations.

In making these, we are first to remove from the bones, the skin, muscles, tendons, and viscera, and, in short, every thing except the connecting ligaments and cartilages, which ought to be carefully preserved. This is done without any regular order of dissection; neither in this part of the process need any attention be paid to making the bones clean. The brain may be removed through an opening in the large fontanel, if the subject is very young, if not, a perforation may be made for that purpose. Some separate the head from the spine, so that the brain may be the more easily removed by the occipital hole. The skeleton is put in water, and allowed to remain for several days; it is then taken out, and more thoroughly cleaned by a knife, forceps, and scissors, and replaced in fresh water. This is repeated from day to day, constantly changing the water, the object being to preserve the ligaments fresh and transparent. It is of great consequence to work hard, by daily scraping and scrubbing, until the bones are deprived of their blood and oleaginous matter, and become white and clean; then remove them into clean lime water, or solution of pearl-ash, for two or three days, to take off any greasiness, and give a more beautiful white. When they have lain long enough, wash them with clean water; they are then placed in a position, by the assistance of a frame, or piece of wood and wire, exposing them to a current of air. When perfectly dry, they may receive a coating of copal or mastic varnish.

It must be kept in view, that if the preparation is allowed to remain too long in the state of maceration, the ligaments themselves will be destroyed by putrefaction, and the intention of procuring a natural skeleton defeated.

An excellent and simple way of procuring natural skeletons of mice, small birds, and fish, is to put them into a box of the proper size, in which holes are bored on all sides, and then buried in an ant-hill. The ants will enter numerously at these holes, and eat away all the fleshy parts, leaving only the bones and connecting ligaments: they may be afterwards macerated in clean water for a day or two, to extract the bloody color, and to cleanse them from any dirt they may have acquired; then whitened by lime and alum water, and dried in frames or otherwise, as may be most convenient. In country situations, wasps may be employed in this service; these are most voracious animals, and if a skeleton is placed near one of their nests, or in an empty sugar cask, where they resort in plenty, they will perform the dissection with much greater expedition, and equally well as the ants. Wasps have been known to clean the skeleton of a mouse, or small bird, in three or four hours, while ants would require a week to effect it.

When the animal is of a large size, the ligaments are sometimes unable to sustain the weight of the bones, in which case, an iron wire, of sufficient thickness, is passed through the centre of the back-bone, which must pass out anteriorly, so as to fix the head to the cervical vertebræ. It is made in the form of two forks, the one for the support of the anterior, and the other for the exterior part; for this purpose two pieces of iron-wire are taken the length of the skeleton; they are twisted together, leaving a fork at each extremity, and are then both fixed to the board on which the skeleton is to be placed. One of these should enter the ribs, and encompass the back bone, between the scapular bones on each shoulder, the other two should pass between the bones of the pelvis.

It not unusually happens that pieces of the skeleton detach one from another, in which case two holes are bored in the ends of the bones, which are separated, and are re-united by means of small brass wires.

Artificial Skeletons.—Skeletons of man and animals of a middling and large size, cannot be made in the manner described for natural skeletons. In this case, the bones, covered by the flesh, are immersed in water, and allowed to remain without changing it, until the soft parts begin to get putrid, when the animal matter is easily removed; and by repeating the maceration two or three times, it may all be completely abstracted. The duration necessary for the first maceration will depend upon the state of the atmosphere, being always much shorter in summer than in winter.

After the fleshy matter has been completely freed from the bones, they should be exposed on the roof of a house, or other convenient situation, until they are rendered quite white, and free from grease.

The fat in bones bears a close resemblance to the fixed oils. In the bones of whales it exists fluid like oil. In the long bones of oxen, horses, and other large quadrupeds, it is semi-fluid, constituting the marrow. When, therefore, this is present in considerable quantity, the process may be much accelerated by drilling holes with a gimlet or other instrument, in the opposite ends of the bones, and injecting by means of a syringe, a tepid solution of pearl-ash, the pot-ash combining with the oleaginous matter, forming a kind of soap, which being soluble in water, is easily removed. Chloride of lime is also employed for the same purpose.

The relative proportion of earthy and animal matter varies according to the nature of the bone, and the purposes it is intended to serve. The bones of quadrupeds and birds contain a much greater proportion of earthy matter than those of reptiles and fishes, and hence are more easily cleaned. Here it may be remarked, that the color of bones varies in different animals. In some common fowl it approaches to a dark yellowish brown. Food exercises considerable influence on the color, as is demonstrated in animals which feed on madder.

When the bones are perfect and dry, they are connected by means of wire and screws, &c. This

is the most difficult part of the operation, as it requires considerable skill to reassemble the bones, so that they may be placed in their natural order and position. The operation is begun at one of the extremities, by making holes in the apophysis, or round ball of the bone. This is effected by means of a wimble or a lathe, or with a gimlet, although this instrument has hardly sufficient power for perforating so hard a substance as bone. The bones are then attached to each other in their natural order, with nealed iron-wire, or brass wire, by means of the perforations which have been made. The ends of the wire should be twisted, and not too firmly, but sufficient to allow a little play between the articulation; this mode is to be pursued till the whole wires are put together. They are then ready for placing on a board, and are kept erect by means of one or two perpendicular bars of iron, commensurate to the weight of the skeleton. In the larger species of birds, one support is necessary; it is passed through the breast bone, and attached under the spine. The position of this support must be varied according to the attitude in which the skeleton is to be placed.

In skeletons of the horse, the ox, the hippopotamus, the rhinoceros, the camel and the elephant, the links of wire which we have above described, are insufficient to unite their bones; for these, two iron pegs are used with a head at one end, and a screw at the other. Each screw is provided with a nut, and each pair of screws must have a narrow plate of iron bored at each end to pass the screw through. Supposing the bones of the leg and thigh, of a large quadruped, are to be united, a hole is bored through the apophysis, about two inches from the extremity, and the same having been done with both leg and thigh-bones, they are brought together, and one of the screws passed into one of the holes of the plates which we have mentioned, and then through the perforations in the bone, and lastly into the other plate; they are tightened together by means of the nut. The screws should be nearly an inch longer than the thickness of the bones. The two ends of the bones are thus united and supported by the two plates which are kept together by the screws. Provision must be made for the play of the bones, by leaving a sufficient distance in boring the holes, through which the pegs are passed.

The horse, and other large animals, require a double bar to support them. A bar is also passed through the vertebræ of the neck, spine, and tail, and the ribs are attached by means of wires, or flat pieces of plate iron.

In these larger animals, the heads are for the most part sawn through, for the purpose of studying the structure of the internal cavity and partitions. These are kept together by means of a hinge, so that they can be opened and shut at pleasure.

CRYSTALLIZATION OF ALUM.

The principle of this pleasing operation has been chiefly confined to the fabrication of flower baskets for chimney ornaments, and the enchasement with an artificial crystal of busts, &c., but the more extensive application of aluminous crystallization may be introduced, as promising a somewhat higher order of gratification, more particularly to the lovers of botany and other branches of natural history.

Dissolve 18 ounces of pure alum in a quart of soft spring water, (observing the same proportion for a greater or less quantity), by boiling it gently in a close tinned vessel, over a moderate fire, keeping it stirred with a wooden spatula until the solution is complete. When the liquor is *almost* cold, suspend the subject to be crystallized by means of a small thread or twine, from a lath or small stick laid horizontally across the aperture of a deep glazen earthen jar, as being best adapted for the purpose, into which the solution must be poured. The respective articles should remain in the solution 24 hours, when they are taken out they are to be carefully suspended in the shade until perfectly dry. The whole process of crystallization is best conducted in a cool situation. When the subjects to be crystallized are put into the solution while it is quite cold, the crystals are apt to be formed too large; on the other hand, should it be too hot, the crystals will be small in proportion. Experiments convinced us that the best temperature is about 95° of Fahrenheit's thermometer.

Among the vegetable specimens, are the common moss-rose of the gardens; the protuberance or *bur* found on the wild rose, *rosa canina*, occasioned by an insect depositing its ova thereon, this should be plucked with its foot-stalk and free of its leaves; small bunches of hops; ears of corn, especially millet-seed, and the bearded wheat; berries of the holly; fruit of the sloe-bush; the hyacinth; pink; furze-blossoms; ranunculus; garden daisy; and a great variety of others: in fact, there are few subjects in the vegetable world that are not eligible to this mode of preservation.

In the animal kingdom, the lizard; large spider; grasshopper; all the beetle kind; the nests of small birds, with their eggs; form beautiful specimens when neatly secured on portions of the branches of the tree, &c. on which they are accustomed to roost. A considerable degree of attention is requisite to prevent too great a deposit of the alum on some of the above-mentioned subjects, by which their beauty would be obscured, they ought therefore to be frequently inspected while crystallization is going on, and removed as soon as it can be ascertained they have acquired a sufficient coating. Various articles of turnery, &c. intended as chimney ornaments, in almost every diversity of form, if first carefully covered over with common cotton wound round them, may be submitted to crystallization with the same beautiful result.

The crystallized subjects may be tinged with almost any variety of color, by boiling in the alum a solution of a little indigo, Brazil wood, logwood, French berries, or other vegetable and mineral dyes. A little care and ingenuity will enable the operator to confine his tints to the crystal surrounding the flower blossoms, and other particular parts of plants which he may wish to preserve.

Among the cryptogamic tribe, the class of lichens, especially the cup-moss, are most eligible subjects, nor are many specimens of fungi less adapted; the two latter tribes of vegetables have moreover the advantage of permanently retaining their own colors, without any aid whatever from art. A thin coating of the crystallizing matter only should be allowed to obtain on most individuals of cryptogamia, which is adequate to their preservation, and essential to the beauty of the specimens.

COLLECTING BRITISH INSECTS.

Woods, Hedges, and Lanes.—By far the greatest portion of insects are found in these situations. In woods, the Entomologist must beat the branches of the trees into his folding net, and must select for this purpose the open paths, skirts, &c. The trunks of trees, gates, and timber which is cut down, should be carefully examined, as a great many Lepidopterous and Coleopterous insects are found in these situations, and in no other. In hedges and lanes, many of the most valuable and beautiful insects are found, as also in nettles and other plants which grow under them; these should be well beat, but more especially when the white thorn blossoms in the months of May and June. Hedges where the roads are dusty are very seldom productive.

Heaths and Commons.—Many insects are peculiar to these situations from the plants which grow on them, as well as from the dung of cattle by which many of them are frequented; in the latter of which many thousands of insects may be found in a single day, in the months of April and May. These are principally of the order Coleoptera.

Sand Pits.—These are favorable for the propagation of *Capris lunarius, Notoxus monoceros, Lixus sulcirostris*, and other rare insects. Minute species are found abundantly at the roots of grass.

Meadows, Marshes, and Ponds.—In meadows, when the Ranunculi, or butter-cups, are in blossom, many *Muscæ* and Dipterous insects generally abound. The flag-rushes are the habitations of *Cassida, Donacina*, and others. Drills in marshes should be examined, as many species of insects are found on long grass. The larvæ of various Lepidoptera, and Neuroptera, are confined to these situations, more especially if hedges and trees are near the spot. Ponds are rich in microscopic insects. These are obtained by means of the landing net, which should be made of pretty thick cotton cloth, but sufficiently thin to allow the water to escape. The mud which is brought up from the bottom of ponds and ditches should be examined, and what small insects are found may be put in a small phial filled with water, which will not only clean them, but keep them alive; and in many instances the naturalist will be surprised upon the examination of these, the most wonderful productions of nature.

Moss, Decayed Trees, Roots of Grass, &c.—Many insects will be found in moss and under it; the roots and wood of decayed trees afford nourishment and a habitation to a number of insects; many of the larvæ of *Lepidoptera* penetrate the trunks of trees in all directions; most of the Cerambyces feed on wood, as well as some species of *Carabidæ, Elateridæ*, &c. In seeking for these, it is necessary to use the digger. It is sometimes requisite to dig six or seven inches into the wood before they are found.

Banks of Ponds, and Roots of Grass.—These are a never failing source of collecting, which may be followed at all seasons of the year, and, in general, with great success; those banks are to be preferred which have the morning or noon-day sun.

Banks of Rivers, Sandy Sea-shore, &c.—These situations afford a great variety of *Coleoptera, Crustacea*, &c. The dead carcases of animals thrown on the shore should be examined, as they are the receptacles and food of *Silphiodæ, Staphilinidæ*, &c. May and June are the best seasons for collecting these insects.

Dead Animals, and Dried Bones, should be constantly examined, for these are the natural habitats of several insects. It is not uncommon for country people to hang dead moles on bushes; under these the entomologist should place his net, and shake the boughs on which they are hung, as many of the Coleoptera generally inhabit these.

Fungi and Flowers.—These are the constant abode of insects, and many curious species will be found on them.

It is a mistaken idea that insects are only to be found in summer, as they are to be met with, either in a living or pupa state, at all seasons. Dried moss, beneath the bark of trees, and under stones, are extremely likely places to find insects in winter; and even then, the entomologist is more likely to procure some of the rare species, than in summer, as these are ranging in search of food, and in situations hidden from view.

At this season, if the weather is mild, the pupæ of *Lepidoptera* will be found at the roots of trees, more especially those of the elm, oak, lime, &c. or beneath the underwood, close to the trees, and these frequently at the depth of some inches under the ground.

In the months of June, July, and August, the woods are the best places to search for insects. Most of the butterflies are taken in those months, flying about in the day-time only. Moths are either found at break of day, or at twilight in the evening. The following method of taking moths is pointed out by Haworth, in speaking of the Oak Moth (*Bombyx Quercus*). "It is a frequent practice with the London Aurelians," says he, "when they breed a female, of this and some other day-flying species, to take her, whilst yet a virgin, into the vicinity of woods, where, if the weather is favorable, she never fails to attract a numerous train of males, whose only business seems to be an incessant, rapid, and undulating flight, in search of their unimpregnated females; one of which is no sooner perceived, than they become so much enamoured of their fair and chaste relation, as absolutely to lose all kind of fear for their own personal safety, which, at other times, is effectually secured by the reiterated evolutions of their strong and rapid wings. So fearless, indeed, have I beheld them on these occasions, as to climb up and down the sides of a cage which contained the dear object of their eager pursuit, in exactly the same hurrying manner as honey-bees, which have lost themselves, climb up and down the glasses of a window."

To the Editor.

SIR.—At our works we are in the habit of using considerable quantities of chloride of lime, for the purpose of bleaching our cotton goods. For this purpose we dissolve, (say two or three hundred weight) of the salt in water, and let the whole affair settle: the clear liquid which floats above is the solution we use. One day last summer, I, by accident, happened to stir up one of the vats where this solution is kept; and was surprised to see a great evolution of a gas; I hastened, got a jar, and collected a considerable quantity. I found I had got *oxygen*, nearly pure. I was perfectly aware that it is a generally acknowledged fact, that chlorine decomposes water; but, I never before have noticed that *free oxygen* was evolved. If it is only a secondary discovery—say where I may find the first notice of the circumstance. A. M.

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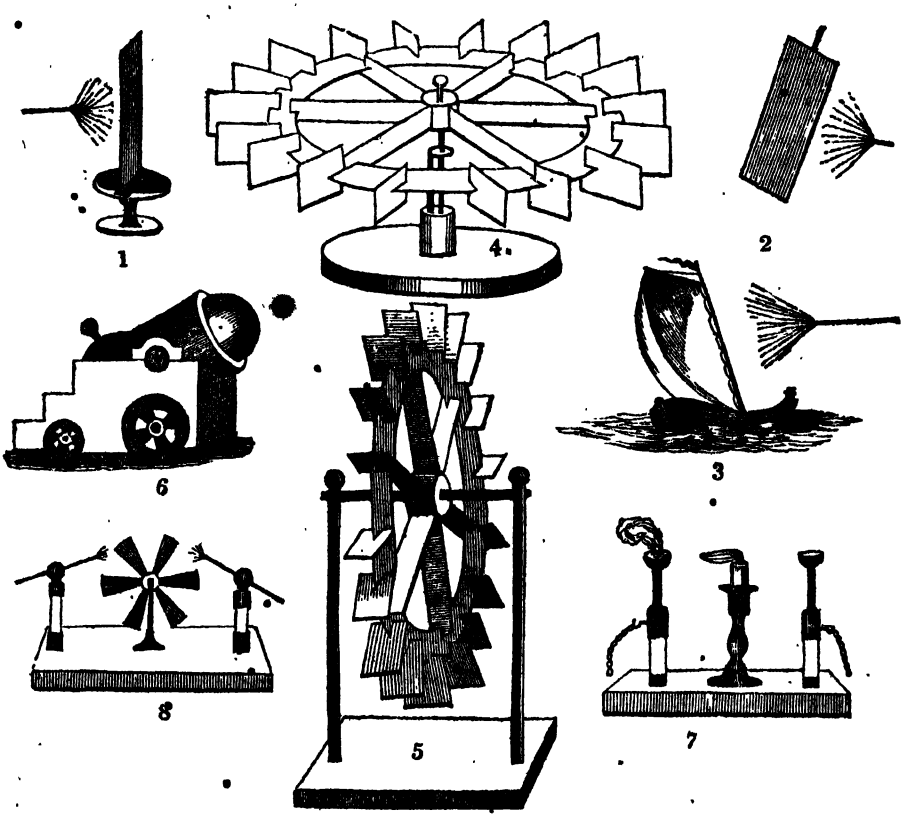


INFLUENCE OF POINTS IN ELECTRICITY.

ELECTRICITY.

(Resumed from page 115.)

WE have in former papers upon this subject had opportunities of witnessing the effect of, and explaining the laws that appertain to the electric fluid in numerous of its phases. It perhaps will be now requisite to consider what is this fluid; for numerous questions will naturally have been asked upon this subject, and the student will desire to know not merely how it acts, but what it is. To satisfy his inquiries fully is impossible, so little do we know of its origin. But that is the case also with heat and light. We know them but from their effects—we can calculate their powers, but their origin escapes us. All therefore that can be urged is supposition, supported it may be by sufficient argument and experiment to go far to change that theory into proof.

The first great question that arises is—Is the electrical fluid material? Or, in other words, Is it a substance? We are inclined to think that it is, and the following remarks and illustrations seem to confirm the opinion.

It is subject to compression and dilatation, as we see in the positive and negative sides of a machine or in a charged phial.

Its attractive and repulsive power is not positive but relative to the particular state of accumulation in which the apparatus exists. It compresses the air in its passage through it as is seen in the spark

—the noise of which is only the collapse of the displaced air to its former state of quiescence.

A stream of the fluid issuing from a point meets with so considerable a resistance in passing into the air, that, by the re-action of the latter, the point whence the fluid issues is immediately put in motion, if so situated as to be capable of it.

A still stronger illustration is the direct influence of a stream of positive electricity when projected against a suspended or slightly-balanced substance. For example, as follows:

Ex. 31.—*Electrical Breeze.*—Stand a card upright upon a table, by a little narrow foot made of cork, so that but a slight force is necessary to overturn it. Hold towards one side of this a point connected with the prime conductor of an electrical machine. Charge the conductor by turning the handle, when the fluid issuing from the point will blow down the card.—Fig. 1.

Ex. 32.—The card, instead of being supported upon a stand, may be suspended by a fine wire, or a linen thread, from the ceiling—when, according to the strength of the fluid, the card will be repelled. —Fig. 2.

Note.—The card must not be suspended by silk, because it would then become charged, and the effect exhibited would be an illustration of repulsion between two charged bodies, and not be dependant upon the mechanical force of the fluid.

Ex. 33.—*Electrical Extinguisher.*—Hold near to the charged point a fresh snuffed lighted candle, the fluid, if strong, will readily blow the flame out.

Ex 34.—*Electrical Cobweb.*—Hold the charged point near the face, and not merely will the hair be blown aside, but the person will have a sensation over his face like that of cobwebs, and hear a whizzing or hissing noise.

Ex. 35.—*Electrical Boat.*—Hold the charged point towards the sails of a small vessel floating in a basin. The issuing of the fluid will occasion the vessel to float away from it.—Fig. 3. (The sail should be of white paper.)

Ex. 36.—*Electrical Vane.*—Make a vane or wheel of paper, or thin pasteboard, (such as is represented in Fig. 4;) and suspend it by a pin upon a piece of brass at the centre. Hold the positive charged point towards one side of it. and opposite the floats, when the wheel will be put into rapid rotatory motion. The wheel may be suspended vertically, (as in Fig. 5,) instead of horizontally, and a system of wheel-work put in motion by the same means.

Ex. 37.—*Electrical Bomb.*—Fig. 6 represents the electrical bomb—the firing of which, if firing it can be called where no fire is, is accomplished by a strong shock of a large Leyden phial or battery sent through it. The bomb is made of ivory, with a small short bore in it, so formed that the ball, which may be of ivory or cork, may be imbedded a trifle more than one half in the bomb, and a cavity of a smaller size be behind it, with two wires entering this small cavity. When a strong shock is passed through these wires, the air withinside will be agitated, and throw out the ball.

Ex. 38.—*Piercing a Phial of Oil.*—Procure a very thin phial, partly fill it with oil, and let a wire, with a ball at one end, and a point at the other, pass through the cork, so far that the point shall touch the side of the phial about half an inch below the surface of the oil; put the thumb against the glass opposite where the point is, and take with the ball a strong spark from the conductor, the fluid will by its momemtum pass through, and make a small hole in the glass opposite the thumb.

In these experiments it is to be remarked, that a positive point is always to be employed, for it has already been shown (page 114) how much more influential is the directive energy from this, than is that from the negative side of the apparatus. Many other experiments might be devised for the same purpose; the two following show the direction in which the electric fluid traverses, and are not merely illustrations of the mechanical force we are now considering, but also go far to show that there is but a single fluid, and not two as some philosophers have supposed.

Ex. 39.—Construct an apparatus, such as is represented in Fig. 7. There being a small metal cup at each side, supported by a glass rod, and a lighted candle in the middle between them. Into each cup put a small piece of phosphorus—connect one chain with the prime conductor, and the other with the cushion. Turn the machine, and the fluid will pass from the positive cup to the lighted wick, and driving this forwards against the opposite cup will soon heat it so as to fire the phosphorus, while there will appear no emanation of the fluid from the negative cup.

Ex. 40.—Fig. 8 represents an apparatus similar to the last, except that it has wires instead of cups, and a light vertical wheel in the centre. Upon connecting the wires with the different parts of the machine, and putting it in motion, the wheel will turn from the positive to the negative side.

These effects are purely mechanical, and are produced by the current of fluid passing to its destination. When the fluid is accumulated by means of the Leyden jar, the mechanical force is proportionably increased, as we shall have numerous occasions of witnessing as we pass onwards in discussing the effects of accumulated electricity.

(To be continued.)

MANUFACTURE OF PHOSPHORUS.

Put 1 cwt. of finely ground bone-ash, such as is used by the assayers, into a stout tub, and let one person work it into a thin pap with twice its weight of water, and let him continue to stir it constantly with a wooden bar, while another person pours into it, in a uniform but very slender stream, 78 pounds of concentrated sulphuric acid.

The heat thus excited in the dilution of the acid, and in its reaction upon the calcareous base, is favorable to the decomposition of the bone phosphate. Should the resulting sulphate of lime become lumpy, it must be reduced into a uniform paste, by the addition of a little water from time to time. This mixture must be made out of doors, as under an open shed, on account of the carbonic acid and other offensive gases which are extricated. At the end of 24 hours, the pap may be thinned with water, and, if convenient, heated, with careful stirring, to complete the chemical change, in a square pan made of sheet lead, simply folded up at the sides. Whenever the paste has lost its granular character, it is ready for transfer into a series of tall casks, to be further diluted and settled, whereby the clear superphosphate of lime may be run off by a syphon from the deposit of gypsum. More water must then be mixed with the precipitate, after sub-

sidence of which, the supernatant liquor is again to be drawn off. The skilful operator employs the weak acid from one cask to wash the deposit in another, and thereby saves fuel in evaporation.

The collected liquors being put into a leaden, or preferably a copper pan, of proper dimensions, are to be concentrated by steady ebullition, till the calcareous deposit becomes considerable; after the whole has been allowed to cool, the clear liquor is to be run off, the sediment removed, and thrown on a filter. The evaporation of the clear liquor is to be urged till it acquires the consistence of honey. Being now weighed, it should amount to 37 pounds. One-fourth of its weight of charcoal in fine powder, that is, about 9 pounds, are then to be incorporated with it, and the mixture is to be evaporated to dryness in a cast-iron pot. A good deal of sulphurous acid is disengaged along with the steam at first, from the reaction of the sulphuric acid upon the charcoal, and afterwards some sulphuretted hydrogen. When the mixture has become perfectly dry, as shown by the redness of the bottom of the pot, it is to be allowed to cool, and packed tight into stoneware jars fitted with close covers, till it is to be subjected to distillation. For this purpose, earthen retorts of the best quality, and free from air-holes, must be taken, and evenly luted over their surface with a compost of fire-clay and horse-dung. When the coating is dry and sound, the retort is to be two-thirds filled with the powder, and placed upon proper supports in the laboratory of an air-furnace, having its fire placed not immediately beneath the retort, but to one side, after the plan of a reverberatory; whereby the flame may play uniformly round the retort, and the fuel may be supplied as it is wanted, without admitting cold air to endanger its cracking.

To the beak of the retort properly inclined, the one end of a bent copper tube is to be tightly luted, while the other end is plunged not more than one quarter of an inch beneath the surface of water contained in a small copper or tin trough placed beneath, close to the side of the furnace, or in a wide-mouthed bottle. It is of advantage to let the water be somewhat warm, in order to prevent the concretion of the phosphorus in the copper tube, and the consequent obstruction of the passage. Should the beak of the retort appear to get filled with solid phosphorus, a bent rod of iron may be heated, and passed up the copper tube, without removing its end from the water. The heat of the furnace should be most slowly raised at first, but afterwards equably maintained in a state of bright ignition. After 3 or 4 hours of steady firing, carbonic acid and sulphurous acid gases are evolved in considerable abundance, provided the materials had not been well dried in the iron pot; then sulphuretted hydrogen makes its appearance, and next phosphuretted hydrogen, which last should continue during the whole of the distillation.

The firing should be regulated by the escape of this remarkable gas, which ought to be at the rate of about 2 bubbles per second. If the discharge comes to be interrupted, it is to be ascribed either to the temperature being too low, or to the retort getting cracked; and if upon raising the heat sufficiently no bubbles appear, it is a proof that the apparatus has become defective, and that it is needless to continue the operation. In fact, the great nicety in distilling phosphorus lies in the management of the fire, which must be incessantly watched, and fed by the successive introduction of fuel, consisting of coke with a mixture of dry wood and coal.

We may infer that the process approaches its conclusion by the increasing slowness with which gas is disengaged under a powerful heat; and when it ceases to come over, we may cease firing, taking care to prevent reflux of water into the retort, from condensation of its gaseous contents, by admitting air into it through a recurved glass tube, or through the lute of the copper adopter.

The usual period of the operation upon the great scale is from 24 to 30 hours. Its theory is very obvious. The charcoal at an elevated temperature disoxygenates the phosphoric acid with the production of carbonic acid gas at first, and afterwards carbonic oxide gas, along with sulphuretted, carburetted, and phosphuretted hydrogen, from the reaction of the water present in the charcoal upon the other ingredients.

The phosphorus falls down in drops, like melted wax, and concretes at the bottom of the water in the receiver. It requires to be purified by squeezing in a chamois leather bag, while immersed under the surface of warm water, contained in an earthen pan. Each bag must be firmly tied into a ball form, of the size of the fist, and compressed, under the water heated to 130°, by a pair of flat wooden pincers, like those with which oranges are squeezed.

The purified phosphorus is moulded for sale into little cylinders, by melting it at the bottom of a deep jar filled with water, then plunging the wider end of a slightly tapering but straight glass tube into the water, sucking this up to the top of the glass, so as to warm it, next immersing the end in the liquid phosphorus, and sucking it up to any desired height.

The tube being now shut at bottom by the application of the point of the left index, may be taken from the mouth and transferred into a pan of cold water to congeal the phosphorus; which then will commonly fall out of itself, if the tube be nicely tapered, or may at any rate be pushed out with a stiff wire. Were the glass tube not duly warmed before sucking up the phosphorus, this would be apt to congeal at the sides, before the middle be filled, and thus form hollow cylinders, very troublesome and even dangerous to the makers of phosphoric match-bottles. The moulded sticks of phosphorus are finally to be cut with scissors under water to the requisite lengths, and put up in phials of a proper size; which should be filled up with water, closed with ground stoppers, and kept in a dark place. For carriage to a distance, each phial should be wrapped in paper, and fitted into a tin-plate case.

PURIFICATION OF WATER ON SEA VOYAGES.

When long kept in wooden casks, water undergoes a kind of putrefaction, contracts a disagreeable sulphureous smell, and becomes undrinkable. The influence of the external air is by no means necessary to this change, for it happens in close vessels even more readily than when freely exposed to the atmospherical oxygen. The origin of this impurity lies in the animal and vegetable juices, which the water originally contained in the source from which it was drawn, or from the cask, or insects, &c. These matters easily occasion, with a sufficient

warmth, fermentation in the stagnant water, and thereby cause the evolution of offensive gases. It would appear that the gypsum of hard waters is decomposed, and gives up its sulphur, which aggravates the disagreeable odour; for selenitic waters are more apt to take this putrid taint, than those which contain merely carbonate of lime.

As the corrupted water has become unfit for use merely in consequence of the admixture of these foreign matters, for water in itself is not liable to corruption, so it may be purified again by their separation. This purification may be accomplished most easily by passing the water through charcoal powder, or through the powder of rightly calcined bone-black. The carbon takes away not only the finely diffused corrupt particles, but also the gaseous impurities. By adding to the water a very little sulphuric acid, about 30 drops to 4 pounds, Lowitz says that two-thirds of the charcoal may be saved. Undoubtedly the sulphuric acid acts here, as in other similar cases, by the coagulation and separation of the albuminous matters, combining with them, and rendering them more apt to be seized by the charcoal. A more effectual agent for the purification of foul water is to be found in alum. A dram of pounded alum should be dissolved with agitation in a gallon of water, and then left to operate quietly for 24 hours. A sediment falls to the bottom, while the water becomes clear above, and may be poured off. The alum combines here with the substances dissolved in the water, as it does with the stuffs in the dyeing copper. In order to decompose any alum which may remain in solution, the equivalent quantity of crystals of carbonate of soda may be added to it.

The red sulphate of iron acts in the same way as alum. A few drops of its solution are sufficient to purge a pound of foul water. The foreign matters dissolved in the water, which occasion putrefaction, become insoluble, in consequence of oxidizement, like vegetable extractive, and are precipitated. On this account, also, foul water may be purified, by driving atmospheric air through it with bellows, or by agitating it in contact with fresh air, so that all its particles are exposed to oxygen. Thus we can explain the influence of streams and winds, in counteracting the corruption of water exposed to them. Chlorine acts still more energetically than the air in purifying water. A little aqueous chlorine added to foul water, or the transmission of a little gaseous chlorine through it, cleanses it immediately.

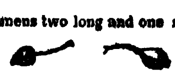
Water-casks ought to be charred inside, whereby no fermentable stuff will be extracted from the wood. British ships, however are now commonly provided with iron tanks for holding their water in long voyages.

ILLUSTRATIONS OF BOTANY.

(Resumed from page 133.)

Class XIV.—Didynamia. Two orders.

Stamens two long and one short.



A totally different guide to classification is now opened. The number of the stamens is not alone to be regarded, reference must also be made to their comparative length. Quite different also is the character of the plant. Their flowers are mostly small, and crowded together in whorls—at least in the first order, which contains the Mints, Lavender, Hyssop, Thyme, Horehound, Dead Nettle, and very numerous others, of a similar kind—all aromatic, carminative, and harmless.

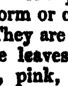
Not so with the plants of the second order—some of them are highly poisonous, for example, the Fox-glove. This flower shows that the class is not without at least one beautiful plant. Nor is this alone, for the Snap-dragon, the Toad Flax, the beautiful Gloxinias, the Bignonias or Trumpet Flowers, the Acanthus, (hallowed by architecture,) and the Musk plant, a species of Mimulus, must not be forgotten—the plants of this class have square hollow stems, lipped corollæ, mostly five-cleft calyces, in the first order, opposite leaves; and generally bear pink, purple, or white colored flowers.

Class XV.—Tetradynamia. Two orders.

Stamens four long and four short.

A class even more natural and uniform in appearance than the last. The plants are immediately known by the cruciform or cross-shaped position of their four petals. They are for the most part small herbs, with alternate leaves and scentless flowers, mostly of a yellow, pink, or white color, rarely blue. Familiar examples of Tetradynamia are seen in the Wall-flower, the Stock, and the Rocket, which are almost the only fragrant plants belonging to the class. Other examples may be found in the Cabbage, the Turnip, the Horse Radish, the Water Cress, the Candy Tuft, the Virginian Stock, the well-known spring salads, Mustard and Cress, and the delicate edible, the Sea Kale.

Class XVI.—Monodelphia. Seven orders.



Stamens united together into one bundle.

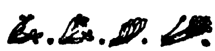
A small class, rendered highly interesting on account of the favorite plants it contains. The Tamarind tree is among them, and one of the most beautiful description. Its leaves are pinnate, and of a fine green, the calyx and corolla yellow, the pods hairy and brown, the whole tree noble in size, and widely spreading out its numerous branches. The Stork's-bill, (commonly called Geranium,) consisting of some hundred species, the Passion flowers, than which the vegetable kingdom does not produce more elegant plants. The Tiger flower is no less elegant. Alas! that it should be so short-

lived, blossoming and dying within a few hours. The extensive family of the Mallows is another beautiful genus, so are the Hibiscus, the Lavatera, and the Holly-hock. We must not forget also that the Cotton tree, and the Camellia, among the species of which are those shrubs which produce the black and green tea, are of the class Monodelphia, and like all others belonging to it are wholesome in properties.

Note.—Tamarinds may be easily grown in a room: it being only necessary first to raise them in a hot-bed. The seeds as found in the preserved fruit, if not too old, will readily germinate, and if potted and brought into an apartment will live through the summer, and not only be elegant plants, but such as will be seen to close their petals every night, and unfold them in the morning—illustrating in an obvious manner the sleep of plants.

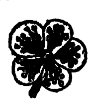
Class XVII.—Diadelphia. Four orders.

Stamens united into two bundles

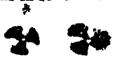


The plants here placed, no less than in some classes already mentioned, contain outward marks by which they may be generally known, namely, their butterfly-shaped flowers, and long pods of seed. There are a very great numoer of this character, not merely distributed over the temperate and tropical regions, but found here either wild or cultivated. Very many of them are thin, delicate, climbing weeds, as the Tare and the Vetch; others are thickly flowering and beautiful trees and shrubs, witness the Acacia, the Laburnum, the Ebony tree, the Coronilla, the Furze, and the Broom. Smaller plants are also common: we all patronize the Sweet Pea, the Lupin, the Kidney, the Scarlet, and the Broad Bean, the Milkwort, and the Milkvetch. The valuable agricultural plants—the Saintfoin, the Lucerne, and the Clover. Our islands alone produce no less than 80 native species of this class, while there have been introduced into cultivation as many as a thousand.

Class XVIII.—Polyadelphia. Two orders.



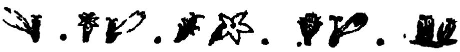
Stamens in several bundles.



An exceedingly small class of showy and useful plants. Headed in the first order by the Chocolate tree. Those splendid green-house plants, the various Melaleucas, commence the second order, shortly followed by the genus Citrus—different species of which are so esteemed, as the Orange, Lemon, Lime, Citron, and Shaddock. The native Polyadelphous plants are confined to the genus Hypericum or St. John's-wort, a showy, yellow, interesting family of plants.

Class XIX.—Syngenesia. Five orders.

Stamens united together by their anthers.



This is a perfectly natural arrangement of plants, which are totally different in character from all others. Their flowers, (such we should call them, if applied to other plants,) are in reality bunches of flowers all upon one receptacle, therefore called *compound* flowers. The Daisy and the Dandelion are well-remembered instances. The gardens owe much of their beauty, particularly in the autumn, to plants of this description. Were the splendid Dahlia, (pronounced Dal-ia, not Da-lea,) the only plant, it would redeem the class from neglect; but this is not all, an infinite multitude of plants, mostly well-known and some of them of surpassing beauty, attract our attention before passing onward. Among them are the Lettuce, the Hawkweed, the Succory, the Burdock, and the Thistle, the Artichoke, the Cacalia, the Lavender Cotton, the Tansy, Wormwood, Everlasting flowers of various kinds, the Colt's-foot-Groundsel, the great family of the Aster or Starwort, Michaelmas Daisy, the Golden Rod, Cineraria, Inula, the different Marigolds, the Zinnia, the Chrysanthemum, Feverfew, Chamomile, Yarrow, the Sunflower, the Rudbeckia, the Coreopsis, and the Corn Cockle. Almost all these plants are bitter, and none of them poisonous.

The numerous genera are distinguished from each other chiefly from the differences observable in the receptacle, the calyx, or involucre, and the seeds, according as they may be bare, or crowned with a pappus.

(To be continued.)

ASSAYING OF METALLIC ORES.

(Resumed from page 144, and concluded.)

Cobalt Ores.—Free them as much as possible from earthy matters by well washing, and from sulphur and arsenic by roasting. The ore thus prepared is to be mixed with three parts of black flux, and a little decrepitated sea-salt: put the mixture in a lined crucible, cover it, and place it in a forge-fire, or in a hot furnace, for this ore is very difficult of fusion.

When well fused, a metallic regulus will be found at the bottom, covered with a scoria of a deep blue color: as almost all cobalt ores contain bismuth, this is reduced by the same operation as the regulus of cobalt; but as they are incapable of chemically uniting together, they are always found distinct from each other in the crucible. The regulus of bismuth having a greater specific gravity, is always at the bottom, and may be separated by a blow with a hammer.

In the Humid Way.—Make a solution of the ore in nitrous acid, or aqua-regia, and evaporate to dryness; the residuum, treated with the acetous acid will yield to it the cobaltic part; the arsenic should be first precipitated by the addition of water.

Mercurial Ores.—The calciform ores of mercury are easily reduced without any addition. A quintal of the ore is put into a retort, and a receiver luted on, containing some water; the retort is placed in a sand-bath, and a sufficient degree of heat given it, to force over the mercury which is condensed in the water of the receiver.

Sulphurated Mercurial Ores.—The sulphureous ores are assayed by distillation in the manner above, only these ores require an equal weight of clean iron-filings to be mixed with them, to disengage the sulphur, while the heat volatilizes the mercury, and forces it into the receiver. These ores should likewise be tried for cinnabar, to know whether it will answer the purpose of extracting it from them: for this a determinate quantity of the ore is finely powdered and put into a glass vessel, which is exposed to gentle heat at first, and gradually increased till nothing more is sublimed. By the quantity thus acquired a judgment may be formed whether the process will answer. Sometimes this cinnabar is not of so lively a color as that which is used in trade; in this case it may be refined by a second sublimation, and if it be still of too dark a color, it may be brightened by the addition of a quantity of mercury, and subliming it again.

Humid Assay of Cinnabar.—The stony matrix should be dissolved in nitrous acid, and the cinnabar, being disengaged, should be boiled in 8 or 10 times its weight of aqua-regia, composed of 3 parts nitrous and 1 of muriatic acid. The mercury may be precipitated in its running form by zinc.

Silver Ores.—Take the assay quantity of the ore finely powdered, and roast it well in a proper degree of heat, frequently stirring it with an iron rod; then add to it about double the quantity of granulated lead, put it into a covered crucible, and place it in a furnace; raise the fire gently at first, and continue to increase it gradually, till the metal begins to work; if it should appear too thick, make it thinner by the addition of a little more lead; if the metal should boil too rapidly, the fire should be diminished. The surface will be covered by degrees with a mass of scoria, at which time the metal should be carefully stirred with an iron hook heated, especially towards the border, lest any of the ore should remain undissolved; and if what is adherent to the hook when raised from the crucible, melts quickly again, and the extremity of the hook, after it is grown cold, is covered with a thin, shining, smooth crust, the scorification is perfect; but, on the contrary, if while stirring it, any considerable clamminess is perceived in the scoria, and when it adheres to the hook, though red hot, and appears unequally tinged, and seems dusty or rough, with grains interspersed here and there, the scorification is incomplete; in consequence of which the fire should be increased a little, and what adheres to the hook should be gently beaten off, and returned with a small ladle into the crucible again. When scorification is perfect, the metal should be poured into a cone, previously rubbed with a little tallow, and when it becomes cold, the scoria may be separated by a few strokes of a hammer. The button is the produce of the assay.

By Cupellation.—Take the assay quantity of ore, roast and grind it with an equal portion of litharge, divide it into 2 or 3 parts, and wrap each up in a small piece of paper; put a cupel previously seasoned under a muffle, with about 6 times the quantity of lead upon it. When the lead begins to work, carefully put one of the papers upon it, and after this is absorbed, put on a second, and so on till the whole quantity is introduced; then raise the fire, and as the scoria is formed, it will be taken up by the cupel, and at last the silver will remain alone. This will be the produce of the assay, unless the lead contains a small portion of silver, which may be discovered by putting an equal quantity of the same lead on another cupel, and working it off at the same time; if any silver be produced it must be deducted from the assay. This is called the witness.

In the Humid Way.—Boil vitreous silver ore in dilute nitrous acid, using about 25 times its weight, until the sulphur is quite exhausted. The silver may be precipitated from the solution by marine acid, or common salt; 100 grains of this precipitate contain 75 of real silver; if it contain any gold it will remain undissolved. Fixed alkalies precipitate the earthy matters, and the Prussian alkali will show if any other metal be contained in the solution.

To Assay the value of Silver.—The general method of examining the purity of silver is by mixing it with a quantity of lead proportionate to the supposed portion of alloy; by testing this mixture, and afterwards weighing the remaining button of silver. This is the same process as refining silver by cupellation.

It is supposed that the mass of silver to be examined, consists of 12 equal parts, called penny-weights; so that if an ingot weighs an ounce, each of the parts will be 1-12th of an ounce. Hence, if the mass of silver be pure, it is called silver of 12 penny-weights; if it contain 1-12th of its weight of alloy, it is called silver of 11 penny-weights: if 2-12ths of its weight be alloy, it is called silver of 10 penny-weights, which parts of silver are called 5 penny-weights. It must be observed here, that assayers give the name penny-weight, to a weight equal to 24 real grains, which must not be confounded with their ideal weights. The assayers' grains are called fine grains. An ingot of fine silver, or silver of 12-penny-weights contains then, 288 fine grains; if this ingot contain, 1-288th of alloy, it is said to be silver of 11 penny-weights and 23 grains; if it contain 4-288ths of alloy, it is said to be 11 penny-weights, 20 grains, &c. Now a certain real weight must be taken to represent the assay weights: for instance, 36 grains represent 12 fine penny-weights; this is subdivided into a sufficient number of other smaller weights, which also represent fractions of fine penny-weights and grains. Thus, 18 real grains represent 6 fine penny-weights; 3 real grains represent 1 fine penny-weight, or 24 grains; a real grain and a half represents 12 fine grains; 1-32nd of a real grain represents a quarter of a fine grain, which is only 1-752nd part of a mass of 12 penny-weights.

Double Assay of Silver.—It is customary to make a double assay. The silver for the assay should be taken from opposite sides of the ingot, and tried on a touch-stone. Assayers know pretty nearly the value of silver merely by the look of the ingot, and still better by the test of the touch-stone. The quantity of lead to be added is regulated by the portion of alloy.

The cupel must be heated red hot for half an hour before any metal is put upon it, by which all moisture is expelled. When the cupel is almost white by heat, lead is put into it, and the fire increased till the lead becomes red hot, smoking, and agitated by a motion of all its parts, called its circulation. Then the silver is to be put on the cupel, and the fire continued till the silver has

entered the lead; and when the mass circulates well, the heat must be diminished by closing more or less the door of the assay furnace. The heat should be regulated, that the metal on its surface may appear convex and ardent, while the cupel is less red; that the smoke shall rise to the roof of the muffle; that undulations shall be made in all directions; and that the middle of the metal shall appear smooth, with a small circle of litharge, which is continually imbibed by the cupel. By this treatment the lead and alloy will entirely be absorbed by the cupel, and the silver become bright and shining, when it is said to lighten; after which, if the operation has been well performed, the silver will be covered with rainbow colors, which quickly undulate and cross each other, and then the bottom becomes fixed and solid.

The diminution of weight shows the quantity of alloy. As all lead contains a small portion of silver, an equal weight with that used in the assay is tested off, and the product deducted from the assay weight. This portion is called the witness.

To Assay Plated Metals.—Take a determinate quantity of the plated metal; put it into an earthen vessel, with a sufficient quantity of the above menstruum, and place it in a gentle heat. When the silver is stripped, it must be collected with common salt; the calx must be tested with lead, and the estimate made according to the product of silver.

Ores and Earths containing Gold.—No. 1.—That which is now most generally used is by amalgamation, the proper quantity is taken and reduced to a powder; about 1-10th of its weight of pure quicksilver is added; and the whole triturated in an iron mortar. The attraction subsisting between the gol and quicksilver, quickly unites them in the form of an amalgam, which is pressed through chamois leather; the gold is easily separated from this amalgam, by exposure to a proper degree of heat, which evaporates the quicksilver, and leaves the gold. This evaporation should be made with luted vessels.

This is the foundation of all the operations by which gold is obtained from the rich mines of Peru. in Spanish America.

No. 2.—Take a quantity of the gold-sand, and heat it red-hot, quench it in water; repeat this two or three times, and the color of the sand will become a reddish brown. Then mix it with twice its weight of litharge, and revive the litharge into lead, by adding a small portion of charcoal-dust, and exposing it to a proper degree of heat; when the lead revives, it separates the gold from the sand; and the freeing of the gold from the lead must be afterwards performed by cupellation.

No. 3.—Bergman assayed metallic ores containing gold by mixing 2 parts of the ore, well pounded and washed, with 1½ of litharge, and 3 of glass; covering the whole with common salt, and melting it in a smith's forge, in a covered crucible; he then opened the crucible, put a nail into it, and continued to do so, till the iron was no longer attacked. The lead was thus precipitated which contained the gold, and was afterwards separated by cupellation.

Humid Assay of Gold mixed with Martial Pyrites.—Dissolve the ore in twelve times its weight of dilute nitrous acid, gradually added; place it in a proper degree of heat; this takes up the soluble parts, and leaves the gold untouched, with the insoluble matrix, from which it may be separated by aqua regia. The gold may be again separated from the aqua regia by pouring ether upon it; the ether takes up the gold, and by being burnt off leaves it in its metallic state. The solution may contain iron, copper, manganese, calcareous earth, or argil; if it be evaporated to dryness, and residuum heated to redness for half an hour, volatile alkali will extract the copper; dephlogisticated nitrous acid, the earths; the acetous acid, the manganese; and the marine acid, the calx of iron, the sulphur floats on the first solution, from which it should be separated by filtration.

CHEMICAL TESTS.

TESTS are substances which detect the presence of other substances in combination with any solvent, or known compound body. Their action depends on the affinity existing between the substance added, and any component part of the body under trial; whereby a new compound body is formed, differing essentially both from the test and the body acted on.

Test for Alkalies.—If a few drops of tincture of turmeric are poured into any alkaline solution (of potass, soda, or ammonia,) the beautiful yellow color of the tincture will be converted to a deep brown. As a more convenient test, a piece of paper, linen, or cotton stained by tincture of turmeric (and kept dry for experiment) may be dipped in a solution of either soda, potass, or ammonia; on withdrawing the test paper, the part immersed will be brown instead of yellow.

Litmus Paper a Test for Acids.—This paper is prepared in the same way as the turmeric paper, only that in this case, tincture of litmus is used. It is an excellent test for the presence of all the acids except the prussic. By these, its fine blue color is invariably converted to deep red.

Test for Carbonic Acid.—Dissolve some carbonate of potass in water, and dip a piece of litmus paper in the solution; it will assume a dark blue color. If it be now withdrawn and held over the vessel, at the same time that sulphuric acid is dropped into it; the wetted part of the paper will be converted from *blue* to *red*. This change arises from the disengagement of the carbonic, by the sulphuric acid, which seizing upon the potass, drives the carbonic acid off with effervescence.

Proof that Potassium is the Base of Potass, and Sodium of Soda.—Dip a half sheet of tumeric paper in a basin of distilled water, and shake off the superfluous drops: spread it on a shallow plate and drop on it a large globule of potassium, or sodium. Either of these will immediately commence a rapid motion in all directions on the paper, staining it of a dark brown color, in lines, as it moves along. Here the potassium or sodium having a great affinity for oxygen, combines with it wherever it is to be found in a weaker state of affinity for any other substance than for itself. In this case, the distilled water is decomposed, and its oxygen set free: the oxygen combining with the metal. The brown color of the stains on the paper, is owing to the action of a new formed substance on the vegetable coloring matter of the turmeric. This new substance is the oxide of potassium, or sodium; or as they are usually called, potass or soda. Therefore potass or soda being alkalies have the characteristic effect of alkalies on this coloring matter.

Test for Iodine.—Dissolve a drachm of starch in half a pint of water; add about five grains of iodine in another half pint: on mixing the solutions, a beautiful blue color will pervade the mixture, and in a short time a precipitate of the same color will take place; which is iodine of starch. The blue color is indicative of saturation; but if the starch prevails, it will have a violet hue, and if the iodine is in excess, the color will incline to black. If in any liquid containing iodine be combined with another substance (besides water) it must be first set free, by adding to the liquid a few drops of sulphuric acid; and then pouring in the solution of starch. In this way a half millionth part of iodine may be discovered in any liquid.

Sulphuric Acid and Barytes, Tests for each other.—Make a solution of twenty grains of muriate of barytes in more than half a wine-glass of pure water: dip the point of a straw into a phial containing sulphuric acid and immerse it in the wine-glass. The whole liquid will become white like milk, this precipitate will soon fall to the bottom, being heavy and very insoluble. Here the sulphuric acid suddenly seizes upon the barytes; forming sulphate of barytes: at the same time driving off the muriatic acid. The vapour of the latter may be identified by holding the nose over the glass at the instant of decomposition. This experiment may be reversed by adding some of the solution of muriate of barytes to a glass of very diluted sulphuric acid.

Tests for Lime.—Into any transparent liquid suspected to contain lime, pour a few drops of a solution of fluate of ammonia: a plentiful white precipitate of fluate of lime (Derbyshire Spar) will fall down in the liquid.

Pour into a solution of lime in any acid (muriatic for example,) some of the solution of oxalate of ammonia; an immediate precipitation will take place of an insoluble salt: the oxalate of lime; muriate of ammonia will be held in solution. It is more proper and convenient to use the oxalic acid in combination with ammonia, as this alkali serves to saturate the acid which has been just disengaged from the lime: otherwise this acid, if in excess, will redissolve the lime. Oxalate of potass also is an excellent test for lime.

Test for Sulphate of Lead in Sulphuric Acid.—As sulphuric acid, in *the large way*, is made by combustion of sulphur with nitrate of potass in leaden chambers, the superficial parts of the lead are often dissolved by it; thus forming sulphate of lead, small portions of which are held in solution by the acid, when sold in the shops. To detect this adulteration, pour a drachm of the acid into a tumbler of distilled water; if a white precipitate falls down, it is a proof of the presence of lead. The affinity of water for sulphuric acid is the cause of this precipitation.

Test for Sulphate of Lime in Water.—Although sulphate of lime is so insoluble a salt, that an ounce of cold water will hardly dissolve one grain of it, still it is surprising, what quantities of it are held in solution in great bodies of water. To discover this salt, add to a tumbler of Thames, or New River water, a drachm of the solution of carbonate of potass. An abundant precipitate of carbonate of lime will instantly take place. Here there is an instance of double decomposition: the carbonic acid combining with the lime, and the sulphuric acid quitting the lime for the potass. The carbonate of lime being very insoluble is precipitated; and the sulphate of potass being soluble in water, remains in the clear liquid. In analysing mineral waters, carbonate of potass is an excellent test, on account of this property of rendering them milky, if they contain sulphate of lime.

General Test for the Metallic Salts.—Into any solution where a metal is suspected to exist in combination, pour a few drops of prussiate of potass: stir the mixture. If a precipitate falls down, it is a proof of the presence of some metal, as this salt has not the power of precipitating salts, of which the earths form component parts. The color and quantity of the precipitate will serve with the assistance of future tests, to demonstrate the name and nature of the metal.

MISCELLANIES.

New Method of Taking a Fac-simile.—Paste a piece of white paper on the inside bottom of a porcelain plate; write upon this paper with common ink, and before it is dry sprinkle upon it very fine powder of gum-arabic, which will afford a slight relief. When the ink is dry, brush off the superfluous gum, and pour into the plate a melted compound of 8 parts bismuth, 7 of lead, and 3 of tin; which is fusible at the boiling temperature of water. Cool it rapidly, to prevent crystallization. A counter-impression of the writing is thus obtained; and by dissolving off the gum in tepid water the plate presents characters, which viewed by a lens are very legible and beautiful. From this plate, by means of common printing ink, true fac-similes of the original writing may be produced. Writing already dry may be copied in the same way, by going over the letters with a pen dipped in a very weak solution of gum—then sprinkling it with the powder, and proceeding as before. The only requisite precaution in this metallo-graphic operation is, that the metallic plate must be of an even thickness, and that the surface on which the characters are traced must be perfectly smooth.

Preservation of Walls from Dampness.—A composition of one part wax, and three parts of oil, previously boiled, with a tenth of its weight of litharge, spread over a wall in a melted state, is a durable and effectual preservative from injury by dampness. When this coating is to be spread upon stone, or other porous matter, it should be heated once or twice previously, which may be accomplished by the partial application of a portable furnace. The composition is then more effectually absorbed. Surfaces of plaster or gypsum, such as walls, busts, reliefs, &c., may in the same manner be preserved from injury. If the cost of wax is an object of importance, resin may be used as a substitute. One part of drying oil, and two or three parts of rosin, form a suitable composition. They may be melted together in an iron or earthen vessel, taking care to manage the heat so as to prevent boiling over. Statues of plaster may be safely exposed to the weather, if well covered with this cement, and if the latter be mixed or compounded with metallic soap, various colors may be given to the statue, so as to make it resemble marble and other durable materials.

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Fig 1.

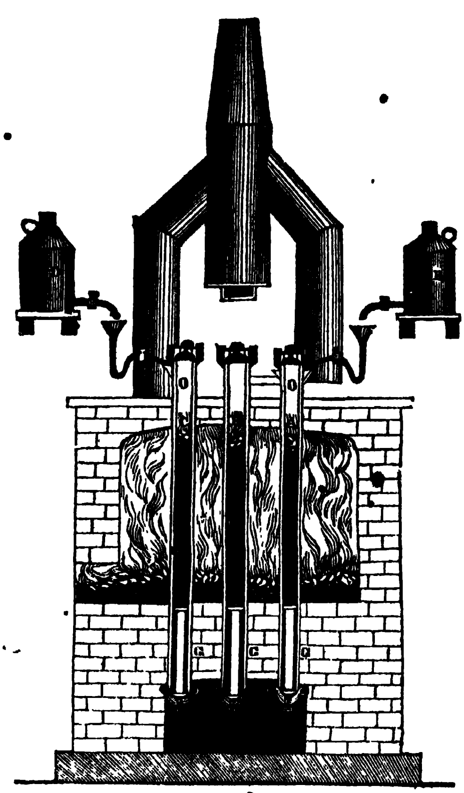
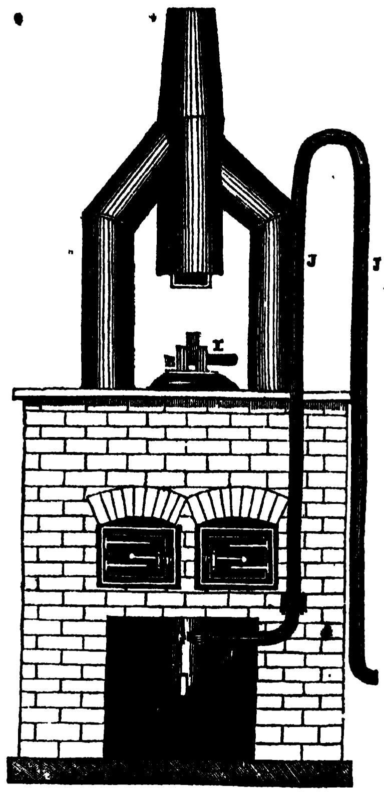
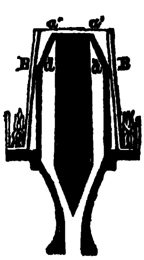


Fig 2.



COUNT VAL MARINO'S APPARATUS FOR MAKING GAS FROM TAR, &c.



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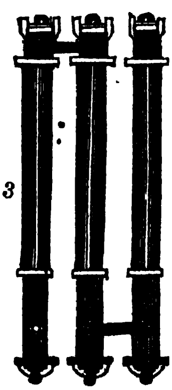

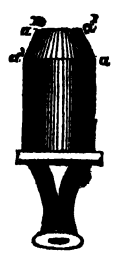

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COUNT VAL MARINO'S PATENT FOR MAKING GAS FROM TAR, &c.

My invention relates, first, to a mode of manufacturing gas for the purpose of light, from coal and other tar and oils, and other fatty matters, together with water; and,

Secondly, my invention relates to an improved arrangement or construction of apparatus or burner for consuming gas for the purpose of light. And, in order to give the best information in my power, I will describe the apparatus used and the process pursued by me in carrying out my invention. And I would first remark, that it is well known that in converting tar, oils, and other fatty matters into gas for the purposes of light, owing to the excess of carbon it contains, and the consequent want of hydrogen and oxygen in converting such matters into gas for the purpose of light, much of the carbon contained therein cannot be beneficially employed; but it is in fact lost in the process of decomposition, owing to the want of a sufficient dose of hydrogen and oxygen in order to convert the whole of the carbon into carburetted hydrogen. And in order to make up for such deficiency of hydrogen and oxygen, requisite for fully saturating the carbon contained in the tar, or in any particular oil or fatty matter, recourse has been had to the decomposition of water, in order to supply such deficiency of hydrogen and oxygen; but up to the present time such processes have not, I believe, been successful, owing to the nature of the process pursued and the apparatus employed.

Now the first part of my invention has for its object a mode of decomposing tar, oils, and other fatty matters, and also water, whereby I am enabled to obtain a more complete combination of the gases evolved, and consequently a more beneficial result than heretofore has been accomplished. And such is the nature of the apparatus and process, that the tar, oil, or fatty matter employed is fully decomposed by being exposed to highly heated surfaces of coke or charcoal, and the water is also fully decomposed in suitable vessels or vessel, and acted on by highly heated coke or charcoal or surfaces. The gas products of the water are, when fully effected, brought into a highly heated retort, or such like vessel, filled with coke or charcoal, wherein the decomposing of the tar, oils, or fatty matters are going on, and by this process, such is the chemical action and reaction of the gases that the carbon contained in the tar, oils, or fatty matters used, becomes fully saturated, and thus may be obtained the whole, or very nearly the whole of the carbon, in the state of carburetted hydrogen gas. It is well known that different tars, oils, and other fatty matters evolve, when decomposed, different relative quantities of carbon, hydrogen, and oxygen, consequently require the decomposition of more or less water to make up the deficiency, by supplying hydrogen and oxygen sufficient to saturate the excess of carbon, in order, under the most favorable circumstances, to produce carburetted hydrogen gas for the purposes of light. Care must therefore be observed in making carburetted hydrogen gas from tar, or from particular oils, or from other fatty matters, to ascertain how much water the same will require to have decomposed. But as an analysis of all, or almost all of such matters is to be found in most modern chemical works, it will not be necessary to enter more at large into this subject, further than to remark, that 1 atom of carburetted hydrogen consists of 2 atoms of carbon, and 2 atoms of hydrogen; 1 atom of oxide of carbon, consists of 2 atoms of carbon and 1 atom of oxygen; and as water, when decomposed, produces 12 per cent. of hydrogen, and the rest oxygen, it follows, that having ascertained the quantity of carbon, hydrogen, and oxygen contained in the particular matter about to be employed in the manufacture of gas, the quantity of water required to be decomposed to make up the deficiency of hydrogen and oxygen will be immediately known. And I would further remark, that in order to fully and most beneficially perform my invention, it is of importance that the retorts or apparatus employed, should be kept at an uniform heat, that is, at a bright white-red heat.

Description of the Drawing.—The drawing, Fig. 1, represents the section of three vertical retorts, suitably arranged for performing my invention; and the furnace is suitably constructed for conveniently heating and maintaining the same at an uniform temperature; A, B, and C, being the three retorts, one for decomposing the tar or oil, or other fatty matter employed, another for decomposing the water, and a third for continuing the products of the water. It is not however material which of the retorts are used for the separate duties, they being all similar. In the arrangement shown, A is the retort in which the water is decomposed; B the retort in which the tar or oil, or other fatty matter is decomposed; and C is the retort into which the gases evolved in the retort A enter, and are further decomposed, the object being fully to decompose the water before the products thereof come into the retort B, to combine with the products of the other retort. D is a vessel containing tar or oil, or other fatty matter; and E is a vessel containing water, under which are 2 syphon pipes, which enter into the upper parts of the retorts A and B; and there are cocks on the vessels, D and E, to regulate the supply. The nature of the retorts, which are of cast iron, is clearly shown in the drawing, each retort having a projecting or descending tube G, connected at the lower end thereof, within which the gratings, which are similar to fire-bars, can be raised and lowered, and the coke or charcoal in the retorts rests on these gratings, which allow of the passage of any small ashes or dust of the coke.

The pipes, Fig. 3, connect the retorts, A and B, and B and C, as is clearly shown in the drawing; and in using this apparatus the three retorts are filled from above, with coke or charcoal, and then the ends of the retorts are to be closed, and all things arranged, as shown in the drawing.

I would here remark, that although I prefer that the retort, C, should contain charcoal or coke, this is not absolutely necessary, and it should be understood, that I prefer the use of coke in consequence of its cheapness, and the retorts are charged with fresh coke every 24 hours; and I have found that I am thereby enabled to retain the temperature required more readily, the retorts being at a good red-white heat, the tar or oil, or fatty matter, and also the water, is to be permitted to flow, observing that the water is allowed to drop, in proportion to the requirement of the other matter employed; and as it is difficult to arrange apparatus to perform this operation with nicety, and as the syphon tubes might become more or less stopped in working, the simplest and the best practical means I am acquainted with for regulating the supply of water to the requirements of the matter employed

is, to have a lighted gas burner near the retort, and within sight of the workman, by this means he will, from time to time, be enabled to observe whether the result of his working is according to the desired object, and if he observes that the flame becomes more colored than is proper, it will indicate that too little water is being supplied, and by this simple means, the workman having once set it right, the working will go on correctly, unless some impediment is offered to the supply of the matter employed or the water. There is a pipe attached to the retort D, leading to the gasometer, for it should be understood that carburetted hydrogen gas thus manufactured will not require purifying, which is an important advantage appertaining to this mode of working. It should be stated that the matter I generally employ and according to the cost of the various matters above mentioned, will, I believe, be most advantageous, is coal-tar; and I would observe that although I prefer the arrangement of apparatus herein described for the purpose of decomposing the matters and water employed, I do not confine myself thereto, provided the mode and process of working be retained as herein described.

I will now proceed to describe the second part of my invention.

Fig. 4, shows an external view of a gas-burner or apparatus for consuming gas, constructed according to this part of my invention; and

Fig. 5, is a section thereof. On examining the drawing, it will be seen that the outer surface of the upper part of the burner, *a*, is coned, as indicated from *a* to *a*; in other respects it is of the ordinary construction; and *b*, is an outer cone which carries the gallery for the glass chimney, consequently the supply of air for the external of the flame will pass between the burner, *a*, and the cone, *b*; and, owing to the upper part of the burner being in the form of a cone, the air will rush up in a direction to pass through the flame, and by this means effect a more perfect combustion of gas supplied to such arrangement of apparatus. It should be remarked, that I am aware that ordinary cylindrical burners have before been used, in combination with an external cone, very similar to *b*. I do not claim the using of such cone uncombined with a coned figure of the outer upper part of the burner, as above explained.

Having thus described the nature of my invention, and the manner of performing the same, I would remark that what I claim, is, first, the mode herein described of manufacturing carburetted hydrogen-gas, from tar, oil, or other fatty matters, by completely decomposing the water, before the products thereof are permitted to enter into that portion of the apparatus, wherein the tar, oil, or other fatty matter is decomposed, and causing the conjoined or combined products to pass in contact with heated surfaces.

Secondly, I claim the method of constructing the apparatus for consuming gas, as herein described.

NEW ZEALAND FLAX.

The *phormium tenax* of naturalists. Its commercial name has been acquired from the circumstance of the natives of New Zealand employing it in the manufacture of their apparel, cordage, and all those purposes for which hemp and flax are used in other countries. The strength of its fibres, however, greatly exceeds those of the last-mentioned vegetable substances; and, indeed, nearly approaches the tenacity of silk. Of this plant there are two sorts,—one bearing a red flower, the other a yellow. The leaves of both are similar to those of the common aloe, but the flowers are smaller, and the clusters more numerous. The Zealanders obtain the flax from them by very simple and expeditious means. The fibres are beautifully fine, and white, shining like silk; the cordage made from it was found by our navigators to be very much stronger than any thing we could produce with hemp. With the view of introducing the growth of so valuable a plant in this country, Captain Ferneaux brought over some of the seeds, which were sown in Kew Gardens, by order of his late Majesty, but unfortunately failed. Subsequent to this period, the culture has been very successfully pursued by our settlers in New South Wales. We are indebted to Mr. William Salisbury, of Brompton, for the discovery of this identical plant, growing indigenously in the south of Ireland, where it flourishes luxuriously.* This discovery will probably prove, ultimately, of the utmost importance to Ireland, where the poor may be profitably employed, both in the culture and subsequent manufacture. Mr. Salisbury observes, that plants of three years old, will, on an average, yield thirty-six leaves, besides a very considerable increase of off-sets; which leaves being cut down, at the time of clearing the quarters in the autumn, are found to spring up again in the following summer.

Respecting the produce, the same gentleman states, "Six leaves have produced me one ounce of fibres, when scutched perfectly clean and dry; at which, an acre of land planted with this crop, at three feet distance from plant to plant, will yield rather more than sixteen hundred weight per acre, which is a very great produce compared with that of hemp or flax. New Zealand flax may be scutched with little labour or trouble, and may be performed by persons in common. The leaves should be cut when full grown, and macerated for a few days in stagnant water, and then passed under a roller machine properly weighted; by this process the fibres become separated, and if washed in a running stream, will instantly become white. When the fibres are thus scutched clean and dry, any kind of friction will cause them to divide into any degree of fineness in the *harle*, so far even, as to cottonize; whereby it is fitted to all the purposes to which hemp and flax are substituted."

This plant is, at present, under cultivation in several parts of England and Wales. It will grow in either a moist or a dry soil; on a hill, or in a valley, but most luxuriously where there is an abundance of moisture.

* This is an error, the plant is not indigenous to Ireland.—Ed.

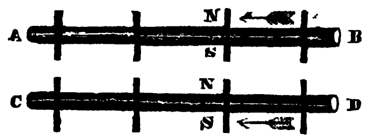
CAUSE OF ELECTRO-MAGNETIC ACTION.

The object of the present, our first paper relative to the subject of electro-magnetism, is to convey a brief, but comprehensive view of the scientific principles upon which the deflections and rotations, which it is the object of its experiments to exhibit, chiefly depend, leaving their further illustration to future opportunities; giving, however, a sufficient explanation of its laws to enable our readers to understand the reason of the effects they witness,

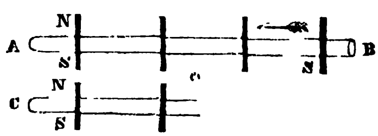
and to calculate before-hand the result of such machines as they may be constructing.

It is first to be remarked, that the sun or some other cause, is constantly exerting such an influence upon the tropical regions, as to occasion a current of electricity to pass around the earth from east to west. In consequence the magnet is diverted from this course, and takes a direction of north and south. What exists in nature we can imitate artificially, and if an electrical current be made to pass along a wire, it forms around that wire an electrical atmosphere. If a magnet be placed within this atmosphere, and be left free to move, it will turn round until it stands across the electrical current—the north pole being in a certain direction, according to the way in which the fluid traverses. If there be several magnets, they will also all turn their north poles the same way, and if there be no magnets at all, yet the conducting wire itself, will for the time be in the same condition—one side of it being north, the other side of it south.

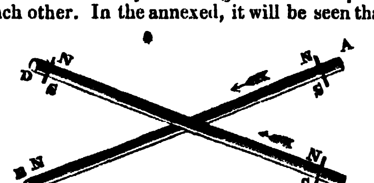
This will be easily understood, and lead us to consider the effect of two wires upon each other, when conveying the fluid along them.



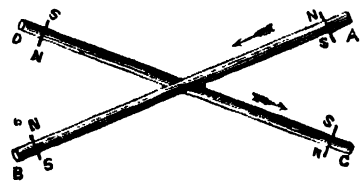
Let A B C D be two wires, conveying the fluid along them in the direction of the arrows—the magnets will stand as represented, the north pole being above the wire in both instances. Now take away the magnets, and suppose the wires themselves to be influenced in like manner—the upper part of each wire will be north; therefore, the parts of the wire nearest to each other will be in different states—one south, the other north, consequently they will attract each other. Thus two wires conveying the fluid in the same direction attract each other, and if they convey the fluid in opposite directions they will repel each other, (see the annexed cut,) in which the two south poles are opposed to each other.



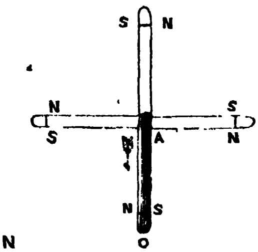
If the conveying wires are oblique to each other, they have a tendency to arrange themselves parallel to each other. In the annexed, it will be seen that at



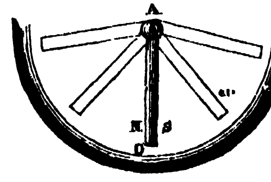
the ends the north and south will attract each other, having a tendency to diminish the angle between them. At the same time at the top and bottom the two north poles and the two south poles are opposed, and consequently repel each other, and tend to increase the angle between them. Again, suppose the fluid in the wire C D be conveyed in the contrary direction, (see Fig.) the effect would be the



contrary, until the wires stand at right angles, when they will follow the law as before. This law may be applied to explain electro-magnetic rotation. Suppose a wire A B, and another wire, A O or A C suspended near it. When in the position A, with the fluid flowing from the centre eastward, it would be attracted by the wire A B, and that end of it which is free to move would move to the wire, until it gets to O, and when here a double force propels it forward, for now S is attracted by N, and N is repelled

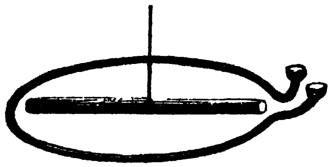


by N, until when it gets again to its horizontal position, when there is only repulsion between N and N. This, however, would continue to act, until the moveable wire reach the zenith, when attraction begins as at first. This, however, would require immense force. To assist the attractive energy then of the wire, we bend it up at each end, so as to be nearer to the moving wire; and if we wish it to have the greatest effect we must move it in a coil quite round the moving wire, and we shall then have an equal attraction of the one side, and repulsion on the other to move it round, and of course continued rotation will be the result.



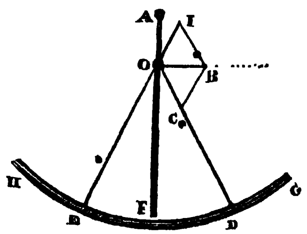
Note.—Be it observed, that this will only explain motion in a horizontal wire, or one suspended in the magnetic meridian, but not a wire moving vertically.

This may be explained as follows: Let the next Fig. represent a coil of wire putting in motion the horizontal magnet within it: it will not only influence the wire, but if the wire were widened into a



band it would attract every vertical section of that band. Thus, suppose a skeleton frame made of a number of vertical wires, the coil would attract every part of each wire.

Then any part of the coil being taken, we shall see its action upon one particle of the wire O. This point O is attracted to D with a certain force O C, and repelled from E with the force O I. Then by the resolution of forces the point O will proceed to the opposite angle of the parallelogram made up of these forces, or to B. The same is the effect produced upon any other particle of the wire O. Of course diminishing in intensity as it approaches the centre, that being the point most distant from the coil.



LOCOMOTION AND LOCOMOTIVE MACHINERY.

Locomotive machines, to be moved by human agency, we have long desired to illustrate; but the examination of all that we could procure a sight or description of, has shown that the task would be invidious and scarcely useful, such ignorance of the laws of mechanics do most of them exhibit. We have had several schemes of this kind submitted to us, but have declined their insertion, because we should have been obliged to have pointed out their imperfections also; and it would have been an odious employment to display the faults of those who had wished to contribute to the utility of our pages, and to whom our thanks were therefore due. We are aware that several friends and correspondents are at work in hopes of accomplishing the desideratum of a manumotive carriage; but before they spend their time and money, we trust they will consider the following facts; first premising that a manumotive carriage is understood to be one whereby a person may move himself with more rapidity, and less labor, than in walking, and that for a continuance of time.

By the action of the feet upon treadles is one way of accomplishing this, the body sitting down. It is evident that every step lengthens out one leg, to propel the treadle to its fullest distance, and draws up the other leg to begin the next step or stroke, and this alternately: when the knee is bent the muscles exert but little force, and it is only when the leg becomes nearly straight, that the strongest of them come into action at all; were it not so this alternate, rapid, and powerful action, would in a very few minutes occasion intense fatigue in the legs, and might very likely snap the tendon Achilles, or great muscle of the leg.

The second method proposed is assisting the action of the treadles by the weight of the body. The action is standing first upon one treadle, and when that is pressed down stepping upon the other, and so alternately. In this the body is lifted up a foot or more at each step (see the Aellopodes, vol. I.) This is the case in working at a tread-mill, and although a considerable effect is produced, yet it is not lasting. It is well known that the utmost time human strength can sustain this labor efficiently is ten or twelve minutes. A projector may say, that in twelve minutes a great space may be passed over; this is true, if the machine be well constructed, and running upon the ice, or even on a smooth board, or a railroad: but it will be remembered, that the more rapid the motion the greater the fatigue.

A third method is by means of a winch turned by the hands: this is subject to the imperfections of the last scheme, and a few others; though human power is better applied here than by the action of the feet, and could the action be continued for any length of time, a winch might be successful; but it cannot, the muscles of the arms become fatigued, as in the former instances.

A fourth method has been proposed, similar to the action of a pump-handle: the fault is the same as before, the short duration of available power: and this is the sticking place of all locomotive projectors.

We have been often asked for our advice upon this matter, and give it freely: 1st. Let our friends avoid all wheels, joints, straps, levers, &c. that can by possibility be done without. Make the machine as light in weight as possible; have it upon three wheels, the first of them a guide wheel, and let the motive action be that of *rowing*, and this for two very essential reasons: 1st. Because the action of rowing can be long continued, even for hours: and 2nd. Because in it the strength of the muscles of the legs, the loins, and the arms, are all called into exercise, without any strain upon either, while the weight of the body is supported by sitting. In advising this method, it is to be remarked, that the strength of the arms is the greatest when pulling about three inches below the breast, and in nearly a straight line towards it; both pulling at the same time, and the feet aiding their action by their pressure against a board. The stroke for the hands may be about two feet six inches, or three feet; and the handles or bar, or whatever else they may take hold of, must not move in the arc of a circle, unless of a very large one. We have little doubt, that upon this principle effective locomotive machines may be

constructed, which will pass with considerable speed on level ground; and think that such a carriage would be of essential use, not merely for exercise, but for the conveyance of intelligence on railways from one post or station to another, in case of accident, or similar necessity.

The following apt remarks upon locomotion in general are abridged from Bingelow's Technology, published in Boston in 1829. He says,

"The chief obstacles which oppose locomotion, or change of place, are gravity and friction, the last of which is, in most cases, a consequence of the first. Gravity confines all terrestrial bodies against the surface of the earth, with a force proportionate to the quantity of matter which composes them. Most kinds of mechanism, both natural and artificial, which assist locomotion, are arrangements for obviating the effects of gravity and friction. Animals that walk, obviate friction by substituting points of their bodies, instead of large surfaces, and upon these points they turn, as upon centres, for the length of each step, raising themselves wholly or partly from the ground in successive arcs, instead of drawing themselves along the surface. As the feet move in separate lines, the body has also a lateral vibratory motion. A man, in walking, puts down one foot before the other is raised, but not in running. Quadrupeds, in walking, have three feet upon the ground for most of the time; in trotting, only two. Animals which walk against gravity, as the common fly, the tree-toad, &c., support themselves by suction, using cavities on the under side of their feet which they enlarge at pleasure, till the pressure of the atmosphere causes them to adhere. In other respects, their locomotion is effected like that of other walking animals. Birds perform the motion of flying by striking the air with the broad surface of their wings, in a downward and backward direction, thus propelling the body upward and forward. After each stroke, the wings are contracted, or slightly turned, to lessen their resistance to the atmosphere, then raised, and spread anew. The downward stroke, also, being more sudden than the upward, is more resisted by the atmosphere. The tail of birds serves as a rudder to direct the course upward or downward. When a bird sails in the air without moving the wings, it is done in some cases by the velocity previously acquired, and an oblique direction of the wings upward; in others, by a gradual descent, with the wings slightly turned, in an oblique direction, downward. Fishes, in swimming forward, are propelled chiefly by strokes of the tail, the extremity of which being bent in an oblique position, propels the body forward and laterally at the same time. The lateral motion is corrected by the next stroke, in the opposite direction, while the forward course continues. The fins serve partly to assist in swimming, but chiefly to balance the body, or keep it upright; for, the centre of gravity being nearest the back, a fish turns over, when it is dead or disabled. The swimming-bladder, which exists in most fishes, though not in all, is supposed to have an agency in adapting the specific gravity of the fish to the particular depth in which it resides. The power of the animal to rise or sink, by altering the dimensions of this organ, has been, with some reason, disputed. Some other aquatic animals, as leeches, swim with a sinuous or undulating motion of the body, in which several parts at once are made to act obliquely against the water. Serpents, in like manner, advance by means of the winding or serpentine direction which they give to their bodies, and by which a succession of oblique forces are brought to act against the ground. Sir Everard Home is of opinion that serpents use their ribs in the manner of legs, and propel the body forwards by bringing the plates on the under surface of the body to act, successively, like feet against the ground. This he deduces from the anatomy of the animal, and from the movements which he perceived in suffering a large coluber to crawl over his hand. Some worms and larvæ of slow motion, extend a part of their body forwards, and draw up the rest to overtake it, some performing this motion in a direct line, others in curves. When land animals swim in water, they are supported, because their whole weight, with the lungs expanded with air, is less than that of an equal bulk of water. The head, however, or a part of it, must be kept above water, to enable the animal to breathe; and to effect this, and also to make progress in the water, the limbs are exerted, in successive impulses, against the fluid. Quadrupeds and birds swim with less effort than man, because the weight of the head, which is carried above the water, is in them, a smaller proportional part of the whole than it is in man. All animals are provided, by nature, with organs of locomotion best adapted to their structure and situation; and it is probable that no animal, man not being excepted, can exert his strength more advantageously by any other than the natural mode, in moving himself over the common surface of the ground. This remark, of course, does not apply to situations in which friction is obviated, as upon water, ice, rail-roads, &c. Thus walking cars, velocipedes, &c., although they may enable a man to increase his velocity in favorable situations, for a short time, yet they actually require an increased expenditure of power, for the purpose of transporting the machine made use of, in addition to the weight of the body. When, however, a great additional load is to be transported with the body, a man, or animal, may derive great assistance from mechanical arrangements. For moving weights over the common ground, with its ordinary asperities and inequalities of substance and structure, no piece of inert mechanism is so favorably adapted as the wheel-carriage. It was introduced into use in very early ages. Wheels diminish friction, and also surmount obstacles or inequalities of the road, with more advantage than bodies of any other form, in their place, could do. The friction is diminished by transferring it from the surface of the ground to the centre of the wheel, or, rather, to the place of contact between the axletree and the boss of the wheel; so that it is lessened by the mechanical advantage of the lever, in the proportion which the diameter of the axletree bears to the diameter of the wheel. The rubbing surfaces, also, being kept polished, and smeared with some unctuous substance, are in the best possible condition to resist friction. In like manner, the common obstacles that present themselves in the public roads are surmounted by a wheel with peculiar facility. As soon as the wheel strikes against a stone or similar hard body, it is converted into a lever for lifting the load over the resisting object. If an obstacle eight or ten inches in height were presented to the body of a carriage unprovided with wheels, it would stop its progress, or subject it to such violence as would endanger its safety. But by the action of a wheel, the load is lifted, and its centre of gravity passes over in the direction of an easy arc, the obstacle furnishing the fulcrum on

which the lever acts. Rollers placed under a heavy body diminish the friction in a greater degree than wheels, provided they are true spheres or cylinders, without any axis on which they are constrained to move; but a cylindrical roller occasions friction, whenever its path deviates in the least from a straight line. The mechanical advantages of a wheel are proportionate to its size, and the larger it is, the more effectually does it diminish the ordinary resistences. A large wheel will surmount stones and similar obstacles better than a small one, since the arm of the lever on which the force acts is longer, and the curve described by the centre of the load is the arc of a larger circle, and, of course, the ascent is more gradual and easy. In passing over holes, ruts, or excavations, also, a large wheel sinks less than a small one, and consequently occasions less jolting and expenditure of power. The wear also of large wheels is less than that of small ones, for if we suppose a wheel to be three feet in diameter, it will turn round twice, while one of six feet in diameter turns round once; so that its tire will come twice as often in contact with the ground, and its spokes will twice as often have to support the weight of the load. In practice, however, it is found necessary to confine the size of wheels within certain limits, partly because the materials used would make wheels of great size heavy and cumbersome, since the separate parts would necessarily be of large proportions to have the requisite strength, and partly because they would be disproportioned to the size of the animals employed in draught, and compel them to pull obliquely downwards, and therefore to expend a part of their force in acting against the ground."

LITHOGRAPHY.

(Resumed from page 131.)

Drawing.—The stone must be well wiped with a clean piece of linen; this is a very necessary precaution, as some dust or sand might still adhere to the stone, in which case the drawing would disappear in those parts.

The draftsman must take great care that no greasy substances be allowed to come in contact with the stone, as these would infallibly mark in the printing; he must on no account touch the surface with his fingers, nor breathe upon it. He must also be cautious lest any spittle should fall on the drawing, and it is necessary to lay a sheet of paper under the hand to avoid any accident.

The sketch may be made with lead pencil or black chalk, observing that the impression will be the reverse of the drawing. One may also, to avoid doing the drawing reversed, make a sketch on paper with a soft pencil, put it on the stone with the drawing towards it, and pass it in the press; by this operation the sketch will be found traced on the stone.

If one wished to have the sketch on the side according to which it is drawn, the paper must be rubbed behind with red chalk or black lead, and applied to the stone; by passing a blunt needle over all the lines of the drawing, the black lead which is on the other side will repeat them all on the stone: to avoid dirtying the back part of every sheet of paper, a separate sheet, rubbed with black lead, may be laid between the drawing and the stone.

It is necessary to have several portcrayons ready with chalk in them, as, from the nature of the chalk, it is apt to get heated and softened by the warmth of the hands.

Drawing with Chalk.—It is well known that the surface of a stone, prepared for a chalk drawing is composed of innumerable little points, which file, as it were, the chalk, and receive on their surface small portions of it; but, according to the second observation, some force must be employed to make it adhere to the stone, and the greater the force the more it will adhere: the draftsman must consequently take care to present to the stone those parts of the chalk which have the greatest degree of cohesion; thus, instead of giving a sharp point to his pencils, he must avoid cutting them as much as possible; and if he is forced to do so by the fineness of the lines, it is better to cut the pencil in the shape of a wedge.

Independently of the different methods of cutting the chalk, there are also different modes of holding it; it may be brought from right to left, held vertically, inclined to the left, so that the point might follow last, or inclined to the right, so that its point might come first. Of all the different positions of the pencil, this last is the one which causes the chalk to adhere the more strongly to the stone; the more it is inclined like an engraving tool, the more certain one will be that the chalk may hold. In short, a better comparison cannot be found than that of a sharp stick, which on being pushed with its point foremost on a rough floor, will catch every protuberance; whereas, if it is merely dragged, it will slip on without any difficulty. The chalk will also hold much better if the drawing is executed without going twice over the different parts, particularly with regard to the soft tints; for each elevation of the stone being charged with different particles of chalk, these cannot adhere so well as when the whole quantity of chalk is laid on at once. Thus it is evident that a drawing which is executed in a free and bold manner must be more successful than one which is often re-touched.

The pencil being cut in the shape of a wedge, the stone well covered with paper, the distances may be firm in the hand, although it may be intended to touch the stone but slightly. When the point of the pencil is turned up by drawing, that part must be taken off with the fingers, as the firm part of the chalk alone must touch the stone.

Different methods may be employed to correct a drawing: if it is wished to make a dark line fainter, parts of it may be picked out with the point of the scraper; if a line is to be completely scratched out, the sharp part must be employed; but this must only be done in case it is not intended to draw on that part again, as this operation destroys the grain of the stone: if a considerable portion of the drawing is to be rubbed out, the glass muller and fine sand must be made use of.

Drawing with Ink.—Ink drawings may be executed with the hair pencil or steel pen, according to the style it is intended to imitate.

The hair pencil is used for all line drawings, writing, ornaments, maps, and landscapes: of all the instruments employed for these purposes this is the most useful: with the brush one may imitate the finest engraving, and the most delicate and sharp lines.

The steel pen is far from being equally good, but as it is more expeditious, it is often employed, particularly for broad touches; in short, the mathe-

matical steel pen is used for all straight lines, and particularly for plans.

Whatever may be the nature of the drawing which is to be executed with lithographic ink, the stone may always be employed as it comes from the workman's hands; consequently, there exists a great difference between the preparation of stones for ink and for chalk drawings, since in the former case the whole surface must be equally polished, while in the latter, the grain ought to be different in different parts.

As it is indispensable that the lines of an ink drawing should be as neat and as pure as possible, it is necessary that the stone should have the highest possible polish. Soft lithographic stones are not good for ink drawings, as they are liable to be scratched by the steel pens, and in general the hardest stones are by far the best: the delicate lines in ink drawings, and the light tints in chalk drawings, print much better with these.

(To be continued.)

PREPARATION OF PIGMENTS.

(Resumed from page 148.)

RED COLORS.

Orange Chromate of Lead, or Sub-chromate of Lead.—This color is not so bright as the minium and realgar; but it is more lasting than yellow chrome. The action of the oils is always too great upon the oxides of lead to allow of this color being quite permanent; it should therefore be used with caution in those draperies where its changing would not be of much importance.

Massicot, (Protoxide of Lead.)—The substances which are sold in the shops, under the name of massicot, are only ceruse more or less calcined, and are named light, yellow, or gold colored. Genuine massicot is the strongest oxide of lead, (protoxide;) its color is a dull orange yellow.

In the preparation of minium the lead is calcined in a reverberatory furnace; this process gives a mixture of massicot and lead; these are separated by washing and trituration; the massicot being much lighter remains suspended in the water; it is drawn off, and left to settle; the *depositum* which it then forms is collected and dried, and this is the true massicot. It may be employed with advantage in preparing the drying oils; it produces the same effect as litharge when very finely ground.

It may also be employed as a color: its tint is not brilliant; but as it is a better drier than white lead, it may be substituted for it in mixing with colors which dry with difficulty, as the lakes and the bituminous earths.

Minium.—A higher degree of oxidation transforms the massicot into minium. On a large scale minium is prepared by calcining massicot in reverberatory furnaces; it becomes first of a dark orange color, then purple, but this last tint disappears on its cooling; when at this point, the doors of the furnaces are closed, but not hermetically, so as to allow of a little air entering. The massicot cools very slowly; and, as it absorbs the oxygen of the air, it becomes of a strong orange color, and grows finer in proportion to the slowness of its cooling.

If, instead of massicot, we calcine ceruse, a peculiar red, called "mineral orange," is obtained, It is a minium, but of a tint more pure and brilliant than any of its class.

Cinnabar.—This is also called vermillion, from the Italian word *vermiglio*, (little worm,) given to the kermes, *(coccus ilicis,)* which was used as the scarlet dye before the discovery of America introduced the cochineal.

Cinnabar is composed of mercury and sulphur, (sulphuret of mercury,) very intimately combined. It is found naturally formed in the quicksilver mines; but that which is used in painting is an artificial production. In Germany and Holland cinnabar is prepared by dissolving one part of sulphur, and adding to it gradually five or six parts of mercury; the mixture becomes black, takes the name of Æthiops mineral, or black sulphuret of mercury; this substance is then reduced to powder, and sublimed in appropriate vessels, when a crystallized mass is obtained, composed of bright filaments of a violet tint; by trituration it becomes of a scarlet color.

But the mere grinding will not be sufficient to give a bright tone to the cinnabar; various methods are employed for that purpose, which are not generally known. Some manufacturers grind these ingredients up with plain water or with urine, and afterwards boil it for some time; others treat it with nitric acid; but it does not happen that any of the methods hitherto employed for heightening the color of cinnabar, obtained by sublimation, give the same brightness as the Chinese vermillion, the preparation of which is not known.

Bucholz has obtained some cinnabar of a very fine description by digesting the following mixture in a sand bath,—one part of flour of sulphur, four parts of mercury, and three of potass, dissolved in six pints of water; this compound first forms black sulphur, and, when the digestion is prolonged, the red color developes itself. The operation could be much shortened by only adding the solution of potass in small portions, to give to the mixture the consistency of thin paste, and supplied as may be required by evaporation, and this, as well as the combination, are facilitated by being stirred constantly by a glass tube.

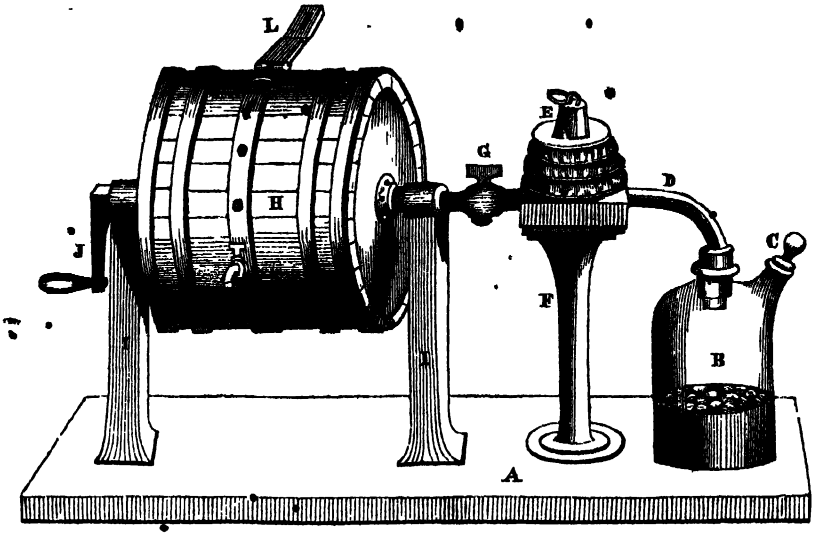
It is not required to have a precise quantity of potass; a greater portion than may be required of this liquid is placed near the vessel, and used with a spoon as occasion may require. By this process several pounds of mercury may be converted into vermillion. The longer the heat of the fire is kept up, the more strongly the color will take the carmine tint. If it be requisite to have it of a clear shade, the fire must be moderated immediately that the color begins to develope itself.

It is very injurious for those employed, to inhale mercurial vapours; for which reason this operation should be performed only in a place where the chimney has a good current of air; there also should be fixed to the tube of glass with which the mixture is stirred a staff sufficiently long to hold at good distance from the vessel; in the same way the spoon should be lengthened with which the potass is added.

When the color has attained the shade required, the vermillion is thrown into a small vat or tube full of water, and it is washed until all the sulphuret of potass is carried off. The advantages derived from this proceeding are, that it produces in a short time vermillion finely prepared, and of the particular shade required.

(To be continued.)

Fig. 1.



AERATED WATERS.

Fig. 2.

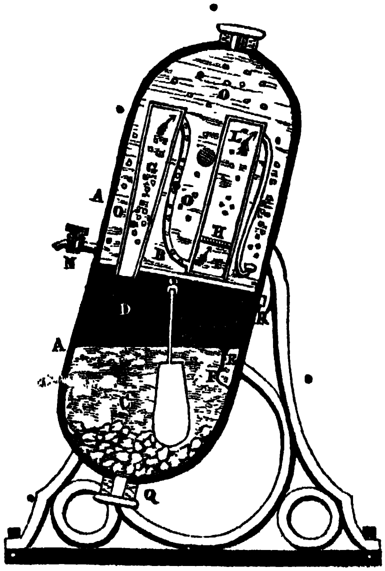
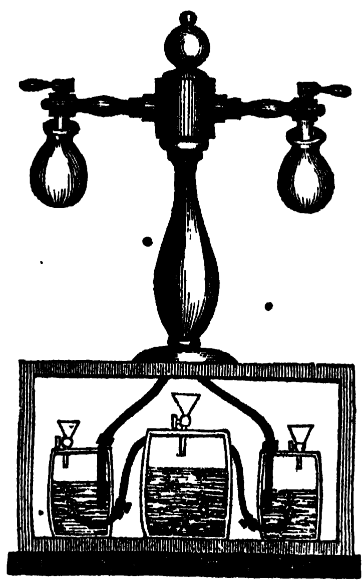


Fig. 3.



AERATED WATERS.

THIS term is popularly applied to a variety of acidulous and alkaline beverages, more or less impregnated with fixed air, or carbonic acid gas, and as the manufacture of these liquids has of late years become of considerable extent, owing to their agreeable as well as medicinal properties, we purpose describing some ingenious apparatuses that have been used, or are still employed, for that purpose. Water absorbs under the natural pressure of the atmosphere about its own bulk or volume of carbonic acid gas. If a pressure be applied equal to two atmospheres, the water will absorb double its own volume, its absorbing power increasing as the pressure. Water thus impregnated acquires a pleasant acid taste, to which is usually added a small quantity of potash or soda, and such flavouring or other ingredients as may be required to imitate the natural mineral waters, or other more favorite beverages, as ginger beer, lemonade, &c., and as such sold in the shops, streets, &c. An apparatus of great simplicity, and adapted to operating upon an extended scale, is delineated in Figure 1.

A is a strong plank on which the vessels are fixed; B is a bottle, containing a quantity of pulverised carbonate of lime or chalk; C is the tubulure and stopper of the bottle; D a bent tube for conveying the gas into the bellows E, which are supported by the upright stand F; G is a stop-cock connected with the tube D, which passes from thence into the strong iron-hooped air-tight barrel H, suspended by its axis on the upright pillars I I. In using this apparatus, the cask is to be half filled with distilled or spring water; the hole at the top is then to be stopped air-tight with a good bung, which is to be fastened down by means of the jointed strap or hasp L, being passed over the staple, and secured by a bolt or key put through the same. Then pour through the tubulure of the bottle some sulphuric acid, diluted with five or six times its weight of water, over the chalk, and close the aperture by the screw-stopper C. Having taken off the weight from the bellows, the carbonic acid extricated from the chalk by the action of the acid, passes out of the bottle into the bellows, through the tube D, which has an orifice opening under them. When the bellows are fully distended, the cock G is to be turned, and the weight being placed upon the bellows, the gas is thereby passed downwards into the barrel, and is there absorbed by the water, which is accelerated by giving the barrel a few quick turns by the winch J. The contents of the barrel may then be drawn off into stone bottles, which should be quickly corked, and bound down with copper wire, to be preserved for use.

A patent has been granted to Mr. F. C. Bakewell, of Hampstead, for a very compact and ingenious apparatus for the preparation of aerated waters, the peculiarity of which consists in the gas generating and the gas impregnating apparatus being inclosed in the same vessel, and in the whole operation being effected by a simple oscillating motion. A correct idea of this machine may be formed by the annexed Figure 2, (representing a vertical section of its principal parts,) together with the subjoined explanation. A A exhibits an external casing of a cylindrical form, with spherical ends, made strong enough to resist a pressure of several atmospheres; B is a partition, separating it into two parts. The bottom part C is a receptacle for the chalk, or other suitable material, mixed into a pasty consistency with water; D is a vessel containing dilute muriatic or sulphuric acid, which is made to pass out in small quantities, as required, at the aperture E into the vessel C; F is a guard to prevent the aperture E from being choked up; G is a pipe, of the form of a truncated cone inverted, being about an inch diameter at bottom, and 2 inches at the top. This pipe is fitted into an aperture in the partition B, and is closed at the upper end; its object is for the ascent of the gas as it is generated, which passes from the top down an external pipe, into the lower part I of a vessel K, and through a small aperture the tenth of an inch diameter, (or through several apertures whose total areas do not exceed the tenth of an inch,) through the partition into the upper part of the vessel H. This vessel, which is denominated the washing vessel, is furnished with two shelves, sloping in opposite directions near its top, to detain the gas longer in its passage through the aperture L to an external pipe, furnished with a perforated rose, for distributing the gas as it escapes into the water to be impregnated, contained in the vessels O O; N is a stop-cock for drawing off the impregnated water as required; Q is an aperture for the introductions of the chalk and water; R, another for the introduction of the acid; and at the opposite end of the vessel, another for the water to be aerated: each of these apertures is provided with a screwed cap, to stop them securely after the respective vessels have been charged. The apparatus is made to swing on two pivots. When the chalk and acid receptacles are to be supplied with those ingredients, the apparatus is to be turned on its pivots to a horizontal position, with the aperture R upwards, and a funnel or hopper, with a bent stem, is to be employed in filling the vessel C, within which is an end view of a pendulum or agitator, " the form of an arc of a circle, extending across the bottom of the vessel, and suspended at its extremity; the suspension wire is shown in the drawing. The apparatus having been charged as above described, is to be put into vibration on its pivots, by which the chalk and water will be effectually agitated by the motion of the pendulum, while a small portion of acid will escape from the vessel D, into the vessel E, to keep up the generation of the gas as it passes off to the water in A, which will, at the same time, by the vibration of the apparatus, be thoroughly mixed with the gas as it escapes through the rose. Some manufacturers of aerated waters employ mechanical means to force the gas into the water, by the use of a transferring pump or syringe, which is connected at one end with a bladder, or other reservoir of the gas, and at the other, with a vessel, or single bottle of water; the up-stroke of the pump extracting the gas from the bladder, and the down-stroke transferring it into the water.

A third apparatus is even more easily constructed and equally efficacious, a representation of it is in Figure 3, and will be recognized as that apparatus commonly called a soda water machine, and seen so frequently in shops where this beverage is sold. The lower part is, of course, hidden beneath the counter, or it may be in a separate apartment, even at a considerable distance. Our Fig. 3, represents below three casks furnished with funnels, fitting air-tight and having cocks in the shank of them. The two outer casks are filled with spring water, one without anything added for soda water—the water in the other cask is flavored with ginger and sweetened with sugar for ginger beer, (1 ounce of ginger and a quarter of a pound of sugar may be used for each

gallon of water.) These casks nave pipes in them, which dip below the surface of the water, and connected above to the cock, where the liquor is drawn off. The centre cask contains the chalk, and has pipes passing from near the top of it to near the bottom of the side casks. To charge the machine first fasten all the tubes that they shall be air-tight; turn the corks at the top off, and the corks between the casks on. Three quarters fill the two side casks, one for soda water, the other for ginger beer; then close the respective funnels. Pour upon the chalk already in the centre cask some very dilute oil of vitriol, and close its funnel. The gas will be generated, pass into the side cask, impregnate the liquor there, and after waiting some time may be drawn off by the cocks above.

Note.—The whole must be made strong enough to bear the inward pressure of the gas, and the various tubes joined by a screw joint. The centre vessel may be and ought to be furnished with a safety valve to prevent accidents.

THE SOLAR SPECTRUM.

It is impossible to trace the path of a sunbeam through our atmosphere without feeling a desire to know its nature, by what power it traverses the immensity of space, and the various modifications it undergoes at the surface and in the interior of terrestrial substances.

Sir Isaac Newton proved the compound nature of white light, as emitted from the sun, by passing a sunbeam through a glass prism, which, separating the rays by refraction, formed a spectrum or oblong image of the sun, consisting of seven colors, red, orange, yellow, green, blue, indigo, and violet; of which the red is the least refrangible, and the violet the most. But when he reunited these seven rays by means of a lens, the compound beam became pure white as before. He insulated each colored ray; and finding that it was no longer capable of decomposition by refraction, concluded that white light consists of seven kinds of homogeneous light, and that to the same color the same refrangibility ever belongs, and to the same refrangibility the same color. Since the discovery of absorbent media, however, it appears that this is not the constitution of the solar spectrum.

We know of no substance that is either perfectly opaque or perfectly transparent. Even gold may be beaten so thin as to be pervious to light. On the contrary, the clearest crystal, the purest air or water, stops or absorbs its rays when transmitted, and gradually extinguishes them as they penetrate to greater depths. On this account, objects cannot be seen at the bottom of very deep water, and many more stars are visible to the naked eye from the tops of mountains than from the valleys. The quantity of light that is incident on any transparent substance is always greater than the sum of the reflected and refracted rays. A small quantity is irregularly reflected in all directions by the imperfections of the polish, by which we are enabled to see the surface; but a much greater portion is absorbed by the body. Bodies that reflect all the rays appear white, those that absorb them seem black; but most substances after decomposing the white light which falls upon them, reflect some colors and absorb the rest. A violet reflects the violet rays alone, and absorbs the others. Scarlet cloth absorbs almost all the colors except red. Yellow cloth reflects the yellow rays most abundantly, and blue cloth those that are blue. Consequently color is not a property of matter, but arises from the action of matter upon light. Thus a white ribbon reflects all the rays, but when dyed red the particles of the silk acquire the property of reflecting the red rays most abundantly and of absorbing the others. Upon this property of unequal absorption, the colors of transparent media depend. For they also receive their color from their power of stopping or absorbing some of the colors of white light and transmitting others. As, for example, black and red inks, though equally homogeneous, absorb different kinds of rays; and when exposed to the sun, they become heated in different degrees; while pure water seems to transmit all rays equally, and is not sensibly heated by the passing light of the sun. The rich dark light transmitted by a smalt-blue finger-glass is not a homogeneous color, like the blue or indigo of the spectrum, but is a mixture of all the colors of white light, which the glass has not absorbed. The colors absorbed are such as, mixed with the blue tint, would form white light. When the spectrum of seven colors is viewed through a thin plate of this glass, they are called visible; and when the plate is very thick, every color is absorbed between the extreme red and the extreme violet, the interval being perfectly black: but if the spectrum be viewed through a certain thickness of the glass intermediate between the two, it will be found that the middle of the red space, the whole of the orange, a great part of the green, a considerable part of the blue, a little of the indigo, and a very little of the violet, vanish, being absorbed by the blue glass; and that the yellow rays occupy a larger space, covering part of that formerly occupied by the orange on one side, and by the green on the other. So that the blue glass absorbs the red light, which, when mixed with the yellow, constitutes orange; and also absorbs the blue light, which, when mixed with the yellow, forms the part of the green space next to the yellow. Hence, by absorption, green light is decomposed into yellow and blue, and orange light into yellow and red. Consequently, the orange and green rays, though incapable of decomposition by refraction, can be resolved by absorption, and actually consist of two different colors possessing the same degree of refrangibility. Difference of color, therefore, is not a test of difference of refrangibility, and the conclusion deduced by Newton is no longer admissible as a general truth. By this analysis of the spectrum, not only with blue glass, but with a variety of colored media, Sir David Brewster, so justly celebrated for his optical discoveries, has proved, that the solar spectrum consists of three primary colors, red, yellow and blue, each of which exists throughout its whole extent, but with different degrees of intensity in different parts; and that the superposition of these three produces all the seven hues according as each primary color is an excess or defect. Since a certain portion of red, yellow, and blue rays constitute white light, the color of any point of the spectrum may be considered as consisting of the predominating color at that point mixed with white light. Consequently, by absorbing the excess of any color at any point of the spectrum above what is necessary to form white light, such white light will appear at that point as never mortal eye looked upon before this experiment, since it possesses the remarkable property of remaining the same after

any number of refractions, and of being capable of decomposition by absorption alone.

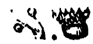
When the prism is very perfect and the sunbeam small, so that the spectrum may be received on a sheet of white paper in its utmost state of purity, it presents the appearance of a ribbon shaded with all the prismatic colors, having its breadth irregularly striped or subdivided by an indefinite number of dark, and sometimes black, lines. The greater number of these rayless lines are so extremely narrow that it is impossible to see them in ordinary circumstances. The best method is to receive the spectrum on the object glass of a telescope, so as to magnify them sufficiently to render them visible. This experiment may also be made, but in an imperfect manner, by viewing a narrow slit between two nearly closed window-shutters through a very excellent glass prism held close to the eye, with its refracting angle parallel to the line of light. When the spectrum is formed by the sun's rays, either direct or indirect—as from the sky, clouds, rainbow, moon, or planets—the black bands are always found to be in the same parts of the spectrum, and under all circumstances to maintain the same relative positions, breadths, and intensities. Similar dark lines are also seen in the light of the stars, in the electric light, and in the flame of combustible substances, though differently arranged, each star and each flame having a system of dark lines peculiar to itself, which remains the same under every circumstance. Dr. Wollaston, and M. Fraunhofer of Munich, discovered these lines deficient of rays independently of each other. M. Fraunhofer discovered that their number extends to nearly six hundred. There are bright lines in the solar spectrum, which also maintain a fixed position. Among the dark lines M. Fraunhofer selected seven of the most remarkable, and determined their distances so accurately, that they now form standard and invariable points of reference for measuring the refractive powers of different media on the rays of light, which renders this department of optics as exact as any of the physical sciences. These lines are designated by the letters of the alphabet, beginning with B, which is in the red near the end of the spectrum; C is farther advanced in the red; D is in the orange; E, in the green; F, in the blue; G, in the indigo; and H, in the violet. By means of these fixed points, M. Fraunhofer has ascertained from prismatic observation, the refrangibility of seven of the principal rays in each of ten different substances solid and liquid. The refraction increased in all from the red to the violet end of the spectrum; but so irregularly for each ray and in each medium, that no law could be discovered. The rays that are wanting in the solar spectrum, which occasion the dark lines, are possibly absorbed by the atmosphere of the sun. If they were absorbed by the earth's atmosphere, the very same rays would be wanting in the spectra from the light of the fixed stars, which is not the case; for it has already been stated that the position of the dark lines is not the same in spectra from star-light and from the light of the sun. The solar rays reflected from the moon and planets would, most likely, be modified also by their atmospheres, but they are not; for the dark lines have precisely the same positions in the spectra, from the direct and reflected light of the sun.

ILLUSTRATIONS OF BOTANY.

(Resumed from page 165, and concluded.)

Class XX.—GYNANDRIA. Three orders.

Stamens united to the style.

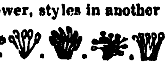


However the plants of other classes may gratify us by their fragrance, their lovely colors, or elegant shapes, it is in Gynandria that we must look for curiosities. On contemplating its genera one might imagine the flowers to represent the most grotesque objects, some like butterflies, bees, gnats, and numerous other insects, are extremely common; some even resemble reptiles, and others are so bizarre and monstrous, that the fancy is in vain taxed for a similitude; yet there is seldom any thing unsightly in their appearance—on the contrary, the majority are of great beauty. They are decked in the most delicate and vivid colors—some with a fine velvetty texture—others shining as if varnished. Their places of growth are no less varied: many Orchises ornament our damp meadows and woods—more of them add a beauty to the dry chalky pastures in the South. The Bee flower and Fly flower are easily recognized. But it is in the tropical regions that they are seen in all their splendid and gorgeous beauty, in Brazil, in Sumatra, and other wooded regions, different of the family of Dendrobium, Oncidium, and others, hang upon the branches of and climb from tree to tree, forming ever-flowering garlands of surpassing magnificence and fragrance; yet without earth to support them, seeming to derive their nourishment from the damp of surrounding air, though in truth they shoot their simply fibrous roots into the stems and branches to which they cling.

Note.—The Bee flower, and other English Orchideous plants, have often been transplanted into gardens, and not flowering the next year are supposed to be dead. This opinion is too general a condemnation: it is usually two or three years before they will fully recover themselves after transplantation, and produce flowers. This is the case also with the Everlasting Pea, and others.

Class XXI.—MONOECIA. Eight orders.

Stamens in one flower, styles in another

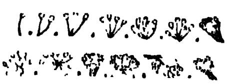


It was observed that the class Icosandria contained almost all our fruit trees. In the present and following are placed the greater part of the timber trees. Their flowers for the most part, (at least those of this climate,) are small, insignificant, and to be found in the very early spring, before the leaves make their appearance. The stamen bearing flowers are mostly in drooping catkins—the pistil bearing ones near, but distinct from them, upon the same

bough. This is the case with the Nut tree, the Alder, the Birch, the Beach, the Hornbeam, and the Oak, all of native growth. Foreign climes, both temperate and tropical, add their contribution. The Bread Fruit tree, the Cocoa Nut, the Sago, the Plane tree, the Mulberry, the Chesnut, and the Walnut, are too important to be omitted. This class, however, does not confine itself to trees. We have the very numerous family of the Sedges, the Stinging Nettle, the beautiful Amaranthus family, the Begonia, and the curious Arums, to join them—and, in the last order, the Cabbage Palm, the extensive families of the Pine trees, the Gourd and Cucumber, the Castor Oil plant, and many others—forming, if not the most beautiful, at least one of the most useful and extensive arrangements.

Class XXII.—Diœcia. Thirteen orders.

Stamens and styles in different flowers, upon different plants.



Few plants of Diœcia are cultivated for ornament, unless in park scenery—though many for their economical uses. The very numerous Willows here hold an important rank. Some of them, with the Poplar trees, the Screw Pine, the Pistachia, the Papaw, the Yew tree, and the Nutmeg, are the largest in the class. These are accompanied by many plants of general interest and value—the Hop, the Yam, the Missletoe, the Hemp, the Spinach, the Zamia, Butcher's Broom, and the Nepenthes distillatoria, or the Pitcher plant—one of the most singular of nature's wonders. It is furnished with appendages to the leaves, which are shaped and closed like pitchers, provided with a moveable lid. As soon as the pitcher becomes filled with water, either by rain or dew, the lid shuts down closely upon it, while it is prevented from turning over by a hook attached to the top, at the back or joint of the lid. When the pitcher becomes empty its lid again opens to let in a fresh supply; and in this singular manner a store of limpid water is preserved. The plants grow in China, and in the swamps of the East Indies; and are by no means rare in cultivation in this country.

Class XXIII.—Polygamia. Two orders.

Flow. perfect or imperfect, upon the same or different plants.

Of flowering plants this class ends the summary: it combines the last two. A rather small class, containing but one British genus, and that of neither beauty nor value, the Orache. Our gardens, green-houses, and hot-houses, derive much of their beauty from the large and beautiful family of the Acacia, one species of which yields the Catechu—another Gum Arabic. The Mimosa family, among which is the elegant Sensitive plant. The Veratrum, is not only useful, but ornamental. The Fan Palm, which is the only European species of that noble family—while the whole concludes with the well-known and valuable Fig; valuable not merely as furnishing a luscious gratifying fruit, but one which affords the chief food to the Greeks, Syrians, and inhabitants of surrounding countries. It is one species of the Fig, Ficus elasticus, which yields the Indian rubber of commerce; and another of them is the far-famed Banian tree, sacred in Eastern story. This wonderful production is of immense magnitude, stretching its branches around, and throwing down stems, or rather roots, at intervals—these increasing, support and nourish the overhanging foliage, until at length a whole forest is formed from a single plant.

"It was a goodly sight to see
That venerable tree,
For o'er the lawn, irregularly spread,
Fifty straight columns propt its lofty head:
And many a long depending shoot
Seeking to strike its root,
Straight, like a plummet, grew towards the ground.
Some on the lower boughs, which crost their way,
Fixing their bearded fibres, round and round,
With many a ring and wild contortion wound,
Some to the passing wind, at times, with sway
Of gentle motion swung;
Others of younger growth, unmov'd, were hung
Like stone drops from the cavern's fretted height
Beneath was smooth and fair to sight,
Nor weeds nor briers deform'd the natural floor,
And through the leafy cope which bower'd it o'er
Came gleams of chequer'd light.
So like a temple did it seem, that there
A pious heart's first impulse would be prayer."

Southey.

Class XXIV.—Cryptogamia.

This class contains all those plants which have no flowers. They are divided into the orders of Feins, Mosses, Hepaticæ, Lichens, Algæ or Sea Weeds, and Fungi or Mushrooms.

Upon a review of the classes we find that the most useful are the 3rd, which produces our corn and grass. The 12th, which furnishes so many of our fruits, and the 21st, to which belong most of our timber trees. We shall also find that all the plants of the 12th, 15th, and 19th may be used as food without danger. Those classes which contain the greatest number of plants are the 5th, 6th, 10th, and 19th. The most beautiful are the 6th, 12th, 13th, 16th, and 17th. The shortest classes are the 1st, 7th, 9th, and 18th. The most curious plants, with a few exceptions, are found in the 20th, 21st, 22nd, and 23rd; and the most minute in the 24th.

ANIMAL STRENGTH.

Of all the first movers of machinery, the force derived from the strength of man or other animals, was first used; and notwithstanding the great power to be obtained from water, wind, steam, heated air, &c., the strength of animals continues in a multitude of cases not only to be the most convenient, but the only applicable source of power. As horses were formerly employed for the same purpose as water-wheels, windmills, and steam-engines now are, it has become usual to calculate the effect of these machines as equivalent to so many horses; and animal strength thus becomes a sort of measure of mechanical force. From these circumstances it is desirable, that a correct estimate should be had of the real strength of those animals, employed for mechanical purposes; but from the nature of animal organization, and from the variety of circumstances in which the living being may be placed in the exertion of its strength, it is impossible to come to any invariable standard; and all that is left for us to do, is therefore to collect together the results of many experiments, and take the average of the whole. We will here present to our readers, a condensed account of all that is yet known on this subject.

When an animal is at rest, and exerts its strength against any obstacle, then the force of the animal is greatest, or the animal when standing still, will support the greatest load. If the animal begins to move, then it cannot support so great a load, because a part of its strength must be employed to effect the motion, and the greater the speed with which the animal moves, the less will be the force exerted on the obstacle, or the less will be the load which it is able to carry, for the greater will be the portion of its strength directed to the movement of its own body; and there will be a speed with which the animal can move and carry no load, but where the whole of its strength is employed in keeping up its velocity. It is clear that in the first and last of these cases, the useful effect of the animal is nothing, in a mechanical point of view. There must, however, be a certain relation between the load and the speed of the animal, in which the useful effect is a maximum. It has been found that the mechanical effect of any animal at work during a given time, is greater when the animal moves with one-third of the greatest velocity with which it can move unloaded, and the load which it bears is four-ninths of that which it can only move. Thus if a man can move through $7\frac{1}{2}$ feet in the second, for ten hours a day, when he is unloaded, and if the weight which he is just able to move be 336 lbs., then the greatest mechanical effect will be obtained when he move at the rate of $2\frac{1}{2}$ feet per second, which is $\frac{1}{3}$ of $7\frac{1}{2}$, and when he carries a load of $149\frac{1}{3}$ lbs., which is four-ninths of 336 lbs. The mechanical effect of any animal depends upon the load which it carries, and the speed with which it moves, conjointly; and thus to find the mechanical effect of an animal, we have only to multiply the load by the speed; hence the mechanical effect of a man carrying a load of 60 lbs., and moving at the rate of 3 feet in the second, is the same as that of a man who moves with a velocity of 2 feet in the second, and carries a load of 90 lbs., for $3 \times 60 = 2 \times 90 = 180$.

We have a few scattered hints on the subject of animal strength, from Smeaton, Euler, Desaguliers, and others, but it is to the labours of Coulomb that we are principally indebted; and the more important of his results we shall therefore present to the reader.

If the average weight of a man be taken at 150 lbs., the quantity of action which he furnishes in going up a stair will be 2560 lbs., raised one yard in one minute, and a man will with convenience carry up a stair 480 lbs., through 1000 yards. In this kind of exertion it was found that the quantity of action of a man loaded, was to one unloaded, as one to two. It must be remembered, however, that quantity of action is a very different thing from useful effect. When a man goes up a stair unloaded, his quantity of action is the greatest possible, but his useful effect is nothing. When he is loaded his quantity of action is less, but his useful effect is more than formerly. In fact, it was found by Coulomb, that the greatest useful effect was produced when the weight which the man bore was 0·756, or $\frac{3}{4}$ of his weight; or assuming the weight of the man to be 150 lbs. as before, the load would be $112\frac{1}{2}$ lbs.

When a man travels unloaded on a level road for several days, he can hardly walk more than 31 miles a day, which gives for the quantity of a man's action in this way 7700 lbs., carried 1094 yards. The quantity of action of a man walking up a stair, is to that when he walks on a level road, as 1 to 17.

The strength of men according to different authors, is very different, as the following table will show:—

Natives of	With the hands.		With the reins.	
Van Dieman's Land	30	6	9	0
New Zealand - -	51	8	14	0
America - - -	58	7	16	2
France - - - -	69	2	22	1
England - - - -	71	4	23	1

According to Robertson Buchanan, the effective strengths of men in working a pump, in turning a winch, in ringing a bell, and rowing a boat, are as

the numbers 100, 167, 227, and 248. According to Mr. Bevan, an ordinary workman is able to use the undernamed tools for a short time, with the forces marked against them.

	lbs.
A drawing knife, with a force of - - -	100
An auger with two hands - - - - -	100
A screw driver, one hand - - - - -	84
A common bench vice handle - - - -	72
A chisel and awl, vertically - - - -	72
A windlass handle, turning - - - -	66
Pincers and pliers, compressing - - -	60
A hand plane, horizontally - - - - -	50
A hand or thumb vice - - - - - -	45
A hand saw - - - - - - - - - -	36
A stock bit, revolving - - - - - -	16
Small screw drivers, or twisting by the thumb or fingers only - - - - -	14

The horse was formerly much employed in the propelling of machinery, and continues still to be so; on which account it is necessary to direct our attention to the measure of the average force of this animal. Of the strength of the horse there is about as much difference of opinion, as that of man. Desaguliers and Smeaton state the strength of a horse to be equivalent to five men; whereas the French writers make it seven. Probably the truth lies somewhat between the two, and we may with Dr. Gregory estimate the strength of a horse to be about 420 lbs., at a dead pull. It is however to be remarked, in comparing the strength of a horse with that of a man, that the most advantageous way to apply the strength of the one, is the least advantageous to the other. The worst way to apply the strength of a horse, is to make him carry a weight up a steep hill, while the structure of a man fits him very well for that purpose; wherefore three men, each bearing a load of 100 lbs., will proceed faster up a hill, than a horse with 300 lbs.

The best way of applying the weight of a horse, is to make him draw a loaded carriage. A horse put into harness and endeavouring to draw, bends himself forward, and inclines his legs, bringing his breast nearer the earth, and this he will do the more, the greater the effort he makes. In this way it is obvious that the effect will depend in some measure upon his own weight, and also upon the weight he has on his back. It is therefore useful to load the back of a horse when in draught, although at first sight it might appear a hindrance; and the more skilful of those who manage draught horses, being aware of this fact, adjust the load upright on the cart, or carriage, so that the shafts throw a portion of the weight upon the horse's back, which portion operates with the weight of the animal in diminishing the exertion of strength necessary for draught, which more than compensates for the burden on the back. The best disposition of the traces while the horse is drawing, is to be perpendicular to the plane of the collar upon his breast and shoulders. When the horse is standing still, the position of the traces is rather inclined upwards, from the direction of the road, but when the horse leans forward to draw the load, the traces should be nearly parallel to the road. If the horse be employed in drawing a sledge or any other thing without wheels, the inclination of the traces to the road, will vary with the proportion of the friction compared with the pressure. Thus if the friction be one-third of the pressure, the inclination of the traces to the road, will be according to a table, (see Gregory's Math. p. 241,) 18½°, and the same table will give the angle for other proportions of friction to pressure.

When a horse is employed in a gin, as is often practised in grinding and thrashing mills, it is desirable to give as great a diameter as possible to the circle in which the animal walks. It is clear that since a rectilinear motion is easiest for the horse, and that with the same velocity the centrifugal force will be less in a large circle, than in a small, which will proportionately lessen the friction in the trunnions, that it is advantageous to have the diameter of the gin circle large.

In practice, it may be stated, that the diameter of the gin walk ought not to be less than 25 or 30 feet.

Mr. Tredgold gives the following view of a horse's daily labour, and maximum velocity unloaded.

Direction of labour in hours.	Maximum velocity in miles per hour unloaded.
1	14·7
2	10·4
3	8·5
4	7·3
5	6·6
6	6·0
7	5·5
8	5·2
9	4·9
10	4·6

Taking the hours of labour at 6 per day; the same author assigns 125 lbs. as the maximum of useful effect, moving at the rate of 3 miles an hour; and regarding the expense of carriage in that case as 1, he gives:

Miles per hour.	Proportional expense.	Moving force.
2	1·125	166
3	1	125
3½	1·0282	104
4	1·125	83
4½	1·333	62 5
5	1·8	41·66
5½	2	56·5

Mr. Tredgold states, that a horse working 6 hours, will raise 2250 lbs. one mile. Mr. Bevan makes the number 2080.

According to Desaguliers, a horse's power is equivalent to 44000 lbs. raised one foot high in one minute of time, Smeaton makes the number 22916; Hachette, 28000; and Watt, 33000.

LIME IN AGRICULTURE.

Quicklime, in its pure state, whether in powder, or dissolved in water, is injurious to plants. Grass is killed by watering it with lime-water. But lime, in its state of combination with carbonic acid, is a useful ingredient in soils. When lime, whether freshly burned or slacked, is mixed with any moist, fibrous, vegetable matter, there is a strong action between the lime and the vegetable matter, and they form a kind of compost together, of which a part is usually soluble in water. By this means, matter which was before comparatively inert, becomes nutritive; and, as charcoal and oxygen abound in all vegetable matters, the lime becomes converted into a carbonate. Mild lime, powdered limestone, marls, or chalks, have no action of this kind upon vege-

table matter; by their action they prevent the too rapid decomposition of substances already dissolved, but they have no tendency to form soluble matter. From these circumstances it is obvious, that the operation of quicklime and marl, or chalk, depends upon principles altogether different. Quicklime, in the act of becoming mild, prepares soluble out of insoluble matter. It is upon this circumstance that the operation of lime, in the preparation of wheat crops depends, and its efficacy in fertilizing peats, and in bringing into a state of cultivation all soils abounding in hard roots, or dry fibres, or inert vegetable matter. The solution of the question, whether quicklime ought to be applied to a soil, depends upon the quantity of inert vegetable matter it contains.—The solution of the question, whether marl, mild lime, or powdered limestone, ought to be applied, depends upon the quantity of calcareous matter already in the soil. All soils are improved by mild lime, and, ultimately, by quicklime, which do not effervesce with acids; and sands are more benefitted by it than clays. When a soil, deficient in calcareous matter, contains much soluble, vegetable manure, the application of quicklime should always be avoided, as it either tends to decompose the soluble matters by uniting to their carbon and oxygen, so as to become mild lime, or it combines with the soluble matters, and forms compounds having less attraction for water than the pure vegetable substance. The case is the same with respect to most animal manures; but the operation of the lime is different in different cases, and depends upon the nature of the animal matter. Lime forms a kind of insoluble soap with oily matters, and then gradually decomposes them by separating from them oxygen and carbon. It combines, likewise, with the animal acids, and probably assists their decomposition by abstracting carbonaceous matter from them, combined with oxygen; and, consequently, it must render them less nutritive. It tends to diminish, likewise, the nutritive powers of albumen, from the same causes, and always destroys, to a certain extent, the efficacy of animal manures, either by combining with certain of their elements, or by giving to them new arrangements. Lime should never be applied with animal manures, unless they are too rich, or for the purpose of preventing noxious effluvia. It is injurious when mixed with any common dung, tending to render the extractive matter insoluble. In those cases in which fermentation is useful to produce nutriment from vegetable substances, lime is always efficacious, as with tanners' bark.

To the Editor.

SIR—If you could oblige me by the insertion of the following original article in your very valuable journal, you would much oblige a constant reader.

THEORY OF THE PRODUCTION OF METEOROLITES, OR METEORIC STONES.

The proposed theory is founded upon the following facts, viz.

1. Meteorolites are entirely composed of iron, nickel, and sometimes a small proportion of cobalt.
2. The three above mentioned metals are the only three susceptible of magnetism.
3. Their descent has always been accompanied by electric phenomena.
4. Wherever there is an electric current, there is always a current of magnetism at right angles to it.
5. Iron the most abundant forms the largest proportion of their bulk.
6. They are never found except in places where nickel is found.

Is it not very probable that the enormously powerful magnetic currents (set in action by the electric currents at or before the time of their descent) may attract the above named metals from the earth, and at the annihilation of the opposite electricities the magnetic currents being destroyed, the metals, unattracted or unretained by any force, fall through the atmosphere, become attractive of each other, form masses, which from the heat produced by their rapid descent are fused, and thus descend again to the earth?

Professor Brande's Lunar Theory seems, I think, very improbable, when we consider that the three metals above mentioned *only* are found entering into their composition;—on account of the small depth to which they penetrate into the earth in their descent, the force not being so great as what they ought to have acquired in travelling from the moon to our earth; also it appears very improbable that any force, however concentrated, could impel bodies of their usual small size from the moon's orbit; the extent of surface presented for the application of any force seems insufficient; and if they came from a volcano in the moon, would you not expect traces of sulphur?

MISCELLANIES.

Answer to Query 186.—The materials for colored printing inks are as under:—

Red—Mineral orange red, 2 oz.; Chinese red, 1 oz.

Blue—Celestial blue, 2 oz.; mazarine blue, 3 oz.

Green—Mineral green, ½ oz.; chrome green, 4 oz.

Brown—Burnt umber, ½ oz.; rose pink, 4 oz.; English vermillion, 2 drams.

Lilac—Prussian blue, ½ oz.; Indian red, 3 oz.

Lilac Pink—Mineral pink, 2 oz.; satin white, or French chalk, 3 oz.

Orange—Mineral orange, 1 oz.; chrome yellow, 2 oz.

Black—French black, 4 lb.; lamp black, 2½ lb.; rock indigo, 2 oz.; Indian red, 2 oz.

The above colors to be ground in printer's varnish. G. C.

Extirpating Weeds.—Weeds may be prevented from growing on gravel walks by watering the walks with salt and water. The salt will also kill the weeds already there; and if these are large, they should, of course, be hoed up and raked off.—*Sherborne Mercury.*

Fluid for Writing on Knife-blades, Saws, &c.—Pound and mix together intimately ½ oz. blue stone, ½ oz. alum, and ½ oz. salt; then put in a wine glass of best vinegar: after standing two or three days, take yellow soap and spread it thinly and regularly on the article to be marked, and write with a common quill pen.

Fig. 1.

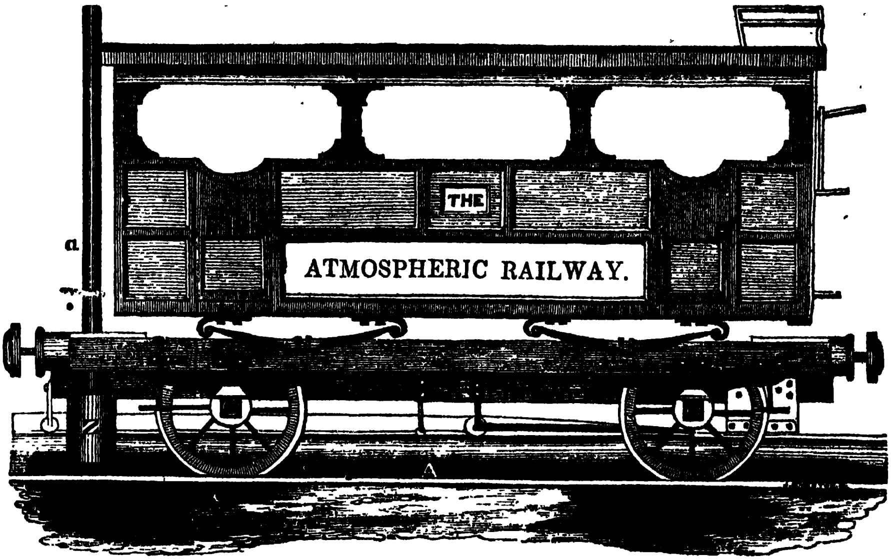


Fig. 2.

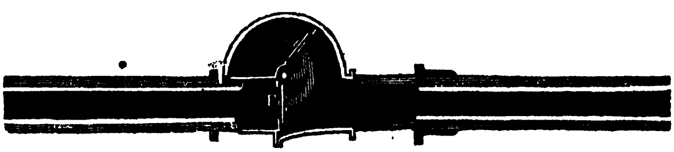
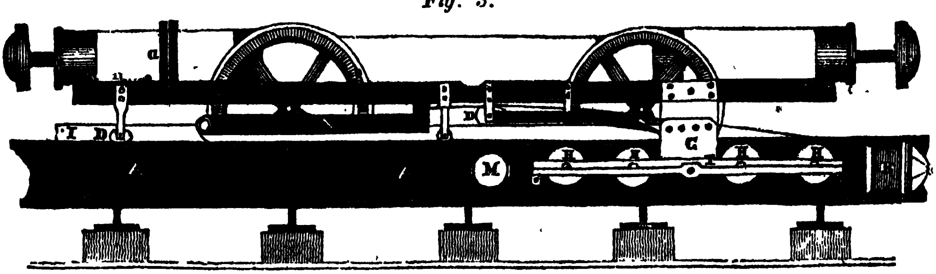


Fig. 3.



ATMOSPHERIC RAILWAYS.

Pneumatic Transport.—In the year 1824, the ingenious Mr. John Vallance, of Brighton, took out a patent for a mode of employing the natural pressure of the atmosphere, operating upon a partial vacuum, for the purpose of transporting persons and goods with extraordinary rapidity from place to place. He proposed to construct hollow cylinders of cast-iron, sufficiently large to allow carriages with passengers and goods to pass through them. A series of these cylinders were to be united, and extend from town to town, and the junctions made sufficiently air-tight to admit of a rarefaction of the air within the tube, by the continued action of powerful exhausting machinery at one end. The carriages, which were to travel inside of this tube, were to be of the same cylindrical form, and very nearly of the same transverse dimensions, so as to constitute, in effect, pistons, which were to be impelled by the air rushing in at one end of the trunk, to restore the equilibrium, or fill up the vacuous space mechanically produced on the opposite side of the pistons. A model, on a sufficiently large scale to test the efficacy of the principle and mode of action, was set up on the patentee's premises at Brighton, and many persons were thus *blown* through the tube. Notwithstanding this demonstration of the correctness of the principle, sufficient subscriptions were not obtained to carry the plan into effect on a greater scale. A notion was very generally entertained that the scheme, if feasible, could not be carried into practice on an extensive scale, and at a cost that would repay the subscribers; to this circumstance may also be added, a fear that the extraordinary mode proposed, of travelling in the interior of a tube, would not accord with the taste of the public. The latter objection was, however, obviated by a novel arrangement of mechanism, which became the subject of a patent granted to Mr. H. Pinkus, whose invention consists in transferring the action produced upon a piston or diaphragm, moving in the interior of a tunnel or tube, to its exterior, by connecting a vehicle or machine, situated within the tube, with a car or carriage without, to which the train of transport carriages are attached. A working model of this invention was first exhibited in Wigmore-street, Cavendish-square; and thus this singular mode of transport gained considerable celebrity, the principle upon which it is founded being essentially correct.

Mr. Pinkus's arrangements were loaded somewhat with unnecessary machinery, and the continuous valve was not sufficiently perfect to ensure certain success—though as the first application of a new principle it deserves the greatest praise, and his more fortunate successors, Messrs. Clegg and Samuda, are indebted to him for every thing except the minor details of the valves, rendering them safer and more easily worked. In this improved condition it is that the atmospheric rail-road is now engaging the public attention. To explain its general principles and construction, we give two extracts, one from the "Engineer's Encyclopedia,"—the other from a "Pamphlet published by Messrs. Clegg and Samuda," and to which latter we beg to refer our readers to estimated profits, expenses, advantages, &c., of the undertaking. It may be had at Weale's Architectural Library, Holborn, price 1s.

"The pneumatic railway admits of several methods of application, in each of which the dimensions, economy, and details, vary. On a line of road where the transit is very great, as, for example, between Liverpool and Manchester, a double line would be required, the cylinders of which, the patentee states, should be 36 inches in diameter, and so moulded, as to be of the average thickness of three-quarters of an inch; that is, the lower semi-circumference to be three-quarters of an inch, and enlarged into a series of rings three feet apart, so as to be 1¼ inch thick where the rings occur; thus giving the lower semi-circumference an average thickness of seven-eighths of an inch. The upper semi-circumference need not be of a greater average thickness than five-eighths of an inch, when disposed into similar rings. On a single line of road, where the transit is considerable, the size of the cylinders may be increased to 40 inches diameter, and be of a proportionate thickness; but when the pneumatic system is combined with a common rail-road, that is, laid between the ordinary rails, as a medium for transmitting motive power to carriages running in the usual manner on rails fixed upon blocks, the cylinder not having to sustain the weight or action of the loaded carriages, may be reduced to 28 inches diameter, and half an inch thick: and when the system is applied to draw or propel barges on canals, (which is also contemplated by the patentee,) a cylinder of only 22 inches diameter, laid down in the towing-path, he considers to be fully adequate. The length of the pneumatic tube will be equal to the whole length of the railway or canal to which it may be applied, and it should be cast in portions of the greatest length possible, in smooth metal moulds, so that their inner sides should be very even and true, and they are to be connected by the ordinary socket joint.

"Figure 1, is a general elevation of the railway, with a train of carriages passing over it.

"Figure 2, is a plan of the railway, with the upper surface of the pipe, at the part containing the entrance separating valve, removed, to show its construction.

"Figure 3, is a longitudinal section of the railway, showing the connection between the piston and the train carriage, and the method of lifting the continuous valve.

"The moving power is communicated to the train through a continuous pipe or main, A, laid between the rails, which is exhausted by air pumps worked by stationary engines, fixed on the road-side, the distance between them varying from one to three miles, according to the nature and traffic of the road. A piston, B, which is introduced into this pipe, is attached to the leading carriage in each train, through a lateral opening, and is made to travel forward by means of the exhaustion in front of it. The continuous pipe is fixed between the rails, and bolted to the sleepers which carry them; the inside of the tube is unbored, but lined or coated with tallow one-tenth of an inch thick, to equalize the surface, and prevent any unnecessary friction from the passage of the travelling piston through it. Along the upper surface of the pipe is a continuous slit or groove, about two inches wide. This groove is covered by a valve extending the whole length of the railway, formed of a strip of leather rivetted between iron plates, the top plates being wider than the groove, and serving to prevent the external air forcing the leather into the pipe when the vacuum is formed within it; and the lower plates fitting into the groove when the valve is shut, makes up the circle of the pipe, and prevents the air from passing the piston; one edge of this

valve is securely held down by iron bars, to a longitudinal rib cast on the pipe, and allows the leather between the plates and the bar to act as a hinge, similar to a common pump valve; the other edge of the valve falls into a groove which contains a composition of bees'-wax and tallow: this composition is solid at the temperature of the atmosphere, and becomes fluid when heated a few degrees above it. Over this valve is a protecting cover, which serves to preserve it from snow or rain, formed of thin plates of iron, about five feet long, hinged with leather, and the end of each plate underlaps the next in the direction of the piston's motion, thus ensuring the lifting of each in succession. To the underside of the first carriage in each train is attached the piston, B, and its appurtenances; a rod passing horizontally from the piston is attached to a connecting arm, C, about six feet behind the piston. This connecting arm passes through the continuous groove in the pipe, and being fixed to the carriage, imparts motion to the train as the tube becomes exhausted; to the piston rod are also attached four steel wheels, H H, (two in advance and two behind the connecting arm,) which serve to lift the valve, and form a space for the passage of the connecting arm, and also for the admission of air to the back of the piston; another steel wheel is attached to the carriage, regulated by a spring, which serves to ensure the perfect closing of the valve, by running over the top plates immediately after the arm has passed. A copper tube or heater, N, about ten feet long, constantly kept hot by a small stove, Z, also fixed to the under side of the carriage, passes over and melts the surface of composition (which has been broken by lifting the valve,) which upon cooling becomes solid, and hermetically seals the valves. Thus each train in passing leaves the pipe in a fit state to receive the next train.

"The continuous pipe is divided into suitable sections (according to the respective distance of the fixed steam engines) by separating valves F and Q, which are opened by the train as it goes along: these valves are so constructed, that no stoppage or diminution of speed is necessary in passing from one section to another. The exit separating valve F, or that at the end of the section nearest to its steam engine, is opened by the compression of air in front of the piston, which necessarily takes place after it has passed the branch which communicates with the air-pump; the entrance separating valve F (that near the commencement of the next section of pipe,) is an equilibrium or balance valve, and opens immediately the piston has entered the pipe. The main pipe is put together with deep socket joints, in each of which an annular space is left about the middle of the packing, and filled with a semi-fluid: thus any possible leakage of air into the pipe is prevented.

"The following accounts of the working of this system on the Birmingham, Bristol, and Thames Junction Railroad, will prove its efficiency.

"The part of the line on which the system is laid down is between the Great Western Railway and the Uxbridge line, on an incline rising part 1 in 120, and part 1 in 115.

"The section of vacuum pipe is half a mile long, and nine inches internal diameter.

"The exhausting pump is 37½ inches diameter, and 22½ inches stroke, worked by an engine of sixteen horse power.

"For the purpose of experiment, a series of posts were fixed along the half mile, every two chains apart, and a guage at each end of the pipe, for the purpose of ascertaining the degree to which the pipe was exhausted. A vacuum equal to a column of mercury of 18 inches was obtained in one and a half or two minutes, and both guages indicated the same extent of vacuum at the same instant."

COLLECTING SHELLS.

In collecting shells the implements required are few in number. The principal of these is a ladle or spoon, made of tin or thin iron, 5 inches long and 3½ wide, with a rim about an inch in height; it may have a short hollow handle, by which it may be fixed to the end of a long walking stick; the middle should be perforated with holes, no larger than is sufficient for the passage of water. This instrument is very useful in fishing for small river shells, or for sifting fine sand on the sea-shore. One or two strong knives will be necessary for separating limpets, ear-shells, &c. from the rocks. A hammer and chisel, for procuring such as perforate; and small tin boxes and bags for containing the specimens. In searching for the larger fresh-water bivalves, a landing net, with very small meshes, is of great service, and it may be made to fit upon the same stick as that which receives the spoon already described.

Marine shells are the most numerous, and there are few situations on the sea-coasts which do not produce some species. The lowest ebb of the tide is the best time for searching for them. The rocks, corals, and stones, which are then left exposed, should be carefully examined for chitons, limpets, ear-shells, and other adhesive tribes, which are fixed upon the surface, or shelter themselves in the crevices. They are detached by suddenly passing a knife between them and the substance they are upon. Muscles, and other gregarious bivalves, furnished with a byssus, likewise occur in such situations. Wherever the rock, mud, or sand, is pierced with round holes, the collector may be tolerably sure of finding bivalves: they are procured either by breaking the rock with a hammer, or digging deep into the sand or mud with a spade. The little puddles of salt water, left by the tide, are the habitations of many univalve shells; and others will be found beneath loose stones and sea-weeds. If any shells appear to have been recently cast up on the beach, and are not broken, they may be collected; but such as have lain some time, exposed to the friction of the waves and the heat of the sun, are scarcely worth that trouble. After a gale of wind, or violent storm, the shore should be immediately visited, as fine shells are frequently to be met with: if the line of coast is extensive, a few boys should be engaged to assist in the search. This must be done quickly; for it not unfrequently happens, that the next flow of the tide takes away every shell. Small islands and coral reefs, not exposed to violent surfs, are generally very rich in shells, particularly in different species of *Spondylus*, tree-oysters *(Dendrostreæ)*, clams *(Tridacnæ)*, winged muscles *(Margaritæ)*, and other adhesive or byssiferous bivalves.

The *trawl*, or dragging net, upon a productive coast, will generally bring up a variety of living

shell-fish, as well as of other marine animals. Whenever dead or broken shells are drawn up with the sounding line, or observed upon the beach, they afford an almost certain indication of the coast being productive. The trawl should be tried in every direction, both in deep and shallow water; and when once the shelly ground has been discovered, the collector may calculate upon procuring a variety of species peculiar to such waters. Shell-fish of a carnivorous nature may be caught in lobster pots, which they frequent for the purpose of feeding upon the offal used as baits. In the Mauritian islands it is a common practice to fish for olive and harp shells with a line and hook baited with flesh: this method, no doubt, might be employed with great advantage on other productive shores. The fish markets in Catholic countries should be regularly visited, particularly during the season of Lent, when shell-fish constitute an important article of food to the inhabitants. In the market of Naples, are often seen fine specimens of *Cardium spinosum* and *aculeatum*, *Pectunculus pilosus*, *Pecten Jacobea*, and *varia*, *Murex brandanus*, and many other species of a smaller size, thus exposed for sale, merely for the sake of the fish. Trawling in the bay would produce, without doubt, a still greater number. At Taranto, according to Swinburne and Ulysses, the variety and abundance of shell-fish is prodigious: the latter author enumerates 185 species, found by himself at Taranto and Naples. Shells, also, are procured by divers or pearl fishers in various parts of India. It has been said that the magnificent collection of shells formed by the late Mr. Griffiths in the island of Sumatra, were nearly all procured in this manner. The sea, in the sheltered bays and coves of tropical climates, is at times so clear and transparent, that objects are distinguished at the depth of fifteen or twenty feet. The collector should avail himself of this, by using a small hand-net fastened to a pole, by which the bottom may be scraped.

The most productive coasts for shells are those of the continent and islands of the Indian Ocean, from whence near one-fourth of the exotic species usually seen in cabinets are brought. It may be taken as a general rule, that the shores of islands abound with more shells than those of continents. Ceylon, Amboyna, Sumatra, and Java, have long been celebrated for their shells; but those from Borneo and New Guinea are very little known. The island of Timor may be called the paradise of conchologists; for it has frequently been averred, that no part of the world can be compared with it in the variety and profusion of its marine productions. The coasts of Australia are considered productive, yet not particularly so. From the Pacific Islands many beautiful and rare species have been obtained; and numerous others, in all probability, remain to be discovered. It is singular, that while the eastern coasts of South America are particularly barren, the western shores are found to be plentifully inhabited by testaceous animals, more especially those of the cyclobranchian tribe, or chitons, numerous species of which, of late years, have been received from Chili. In Britain, the west of England affords nearly two-thirds of all the marine species yet discovered. The coast of Exmouth, Sandwich, and Weymouth, are particularly productive; so likewise are those of Tenby, Barmouth, Hastings, &c. In Ireland, Dr. Turton has explored Bantry Bay, and the celebrated silver strand of Portmarnock, in Dublin Bay, with great assiduity and singular success; while in Scotland, a considerable number of rare and interesting shells have been discovered in the Frith of Forth, by Captain Laskey, and accurately described by him in the *Transactions of the Wernerian Society*.

Fluviatile shells may be sought for in fresh-water lakes, ponds, rivers, streams, and ditches filled by brooks. The greatest number of the univalves occur at or near the surface, under the leaves of aquatic plants, among decayed vegetables, &c. The bivalves, on the other hand, as also the *Ampullariæ*, *Melaniæ*, *Paludinæ*, among the univalves, are only to be found at the bottom, either among the pebbles, or partly imbedded in the sand or mud: the first are easily captured by the hand, or by the spoon already described; but the different species of *Cyclas*, *Unio*, *Anodon*, &c., from fixing themselves within the mud (very often two or three inches beneath the surface), can only be extracted by a strong semi-circular landing net, somewhat resembling a drag in miniature—the curved portion being that to which the handle is attached, while the straight side is in front: this side, which comes in contact with the bottom, might be furnished with three or four iron prongs, like a rake, which would detach the shells from the mud; while the net, being drawn forward, would receive them. Many of the European fluviatile bivalves are minute, and can only be secured by a net with very small meshes. There are scarcely any situations in this country where fresh-water shells may not be found. The exotic species should particularly engage the attention of the collector. The great rivers and lakes of North America abound with a surprising number of these bivalves, many of which grow to a very large size and astonishing thickness. Although we are now well acquainted with those of North America, few, comparatively, have yet been brought from the tropical regions of that continent,—still fewer from Asia, and scarcely any from Africa. As no cause has been assigned for such a singular disparity, we may presume it is occasioned by the fresh waters of those regions not having been sufficiently examined.

Land shells occur in all countries, and are found in various situations; as humid spots covered by herbage, rank grass, &c.; beneath the bark, or within the hollows of old trees, crevices of rocks, walls, bones, &c. Early in the morning, during a damp sunless day, or after showers of rain, land mollusks may be found crawling on the leaves of plants, the stems of trees, &c. The animals will sometimes live in a torpid state for one or two years after they have been removed from their native country: it is therefore highly desirable that this experiment should be tried with a few of each species; packing them in moss, or loose vegetable earth, but in such a way that they may not be shaken during the voyage.

The animals of all shells may be killed with warm water, in which they should remain two or three hours. The water must not boil, otherwise the colors, in many cases, will be changed or injured. Previous to removing the animal, the shells should be simply cleaned with water and a hard brush. Spirits of salt, or other acids, on no account should be used: they are, indeed, employed to remove scurf, or any extraneous bodies that sometimes hide the beauty of the specimens; but their application requires much skill, and will prove destructive in the hands of inexperienced persons. When the shells, therefore, have been cleaned with a brush, the dead animals can be removed with a stout pin.

or the point of a knife: the latter will be necessary for cutting the two muscles, generally found in bivalves, and by which the valves are closed. The animals of these shells are never dead until these muscles are relaxed, and the valves begin to gape. During this operation, great care must be taken not to injure the teeth; and it is desirable that the ligament should be preserved entire. The operculum, or lid, which closes the mouth of univalves, should be carefully detached, wrapped in paper, and replaced within the aperture. The shells may be left to drain upon a towel and board placed in the shade. In tropical countries, the assistance of ants may be called in with advantage.

In *packing* shells, the smaller and more delicate kinds will be best secured from injury in chip boxes; to these should be affixed labels, stating the place they were found in, and any other circumstances. Those armed with long and tender spines had better be enveloped in cotton or tow, until their points are completely covered: the rest may be wrapped in cotton, paper, or other soft substance, and closely packed; taking care to put the largest and heaviest at the bottom, and filling up the interstices with the smaller species. Many of these latter, also, may be packed, with greater security, within the large ones; thus the risk of injury will be diminished, and much space saved.

CHEMICAL TESTS.

(Resumed from page 168.)

Test for Iron in Mineral Waters.—To any mineral water, suspected of containing iron, add a little lime water: a precipitate of carbonate of lime, mixed with a portion of oxide of iron, which is of a light brown color, will fall down. Pour a few drops of the solution of succinate of ammonia into a wine glass containing any fluid where iron is suspected to exist; for example, a solution of the muriate of iron: there will instantly be a copious precipitate of succinate of iron, whilst muriate of ammonia will be held in solution. Chalybeate waters may thus be proved to have iron in solution.

Test for Gold in Solution.—Pour about ten or twelve drops of nitro-muriate of gold into a wine glass containing distilled water; the mixture will in the present case be colorless, but if it be stirred round with a piece of tin, or a slip of tinned iron, it will assume the appearance of port wine. This precipitate, (which is the same as that known by the name of the *purple precipitate of Cassius*,) will soon fall down in the form of a purple powder.

Test for Platinum and for Potass.—Pour some of the solution of carbonate of potass into a wine glass, containing some diluted nitro-muriate of platinum: a yellow* precipitate will fall down. As a solution of soda has not this effect, a very ready way of discovering the existence of potass in combination, is by letting fall a few drops of the nitro-muriate into the suspected solution.

Test for Iron and Copper in Alum.—Sulphate of alumine and potass very often contains sulphates of iron and copper. These may be detected as follows: dissolve two drams of the alum in hot water, and pour the solution into different wine glasses, into one of these pour a few drops of a solution of prussiate of potass; if iron be present, a dark blue precipitate will take place; this is the prussiate of iron, or Prussian blue. Into the other glass pour a solution of pure ammonia: if copper be present, a beautiful light blue color will pervade the liquid, from the precipitation of ammoniuret of copper.

Tests for Tellurium.—In a solution supposed to contain tellurium, immerse a tin rod. If tellurium be present, it will be precipitated on the rod in the metallic state, it will have a greyish white lustre similar to the tin itself. To prove beyond doubt the existence of the tellurium in the solution, the precipitated metal should be wiped off from the rod by a feather on a piece of paper. A further test for the presence of this metal, is a small quantity of the subcarbonate of potass, which will throw down a white precipitate. Experiments should be made with both these on different portions of the liquid to be tested.

Tests for Lead and Copper in Wine, &c.—Put into a crucible one ounce of sulphur, and one ounce of pure lime, and keep them in a white heat for nearly half an hour; when cold, add one ounce of the super-tartrate of potass, and boil the whole in a mattress with some distilled water for about half an hour. Decant the supernatant liquor into small phials, adding about twenty or thirty drops of muriatic acid to each. The phials must be well stopped and preserved for use. Lead, copper and other deleterious metals will be precipitated, of a black color, by this liquid, if poured, in the quantity of only a few drops, into the suspected wine or cyder. The muriatic acid is added to this test, to prevent the precipitation of iron, which might exist in the wine without any mischief resulting from its use.

Another test for these pernicious metals in wine and cyder, exists ready formed in nature. Pour into a glass of suspected wine, cyder, or perry, a few drops of Harrowgate water. If any lead, &c., be present, it will fall down in the state of a black precipitate, being combined with the sulphuretted hydrogen by which these waters are impregnated.

(To be continued.)

THE CHARCOAL GALVANIC BATTERY.

BY MR. SMEE.

MR. SMEE says, that "When a diamond is placed in contact with amalgamated zinc in dilute sulphuric acid, no gas is given off, nor copper precipitated on it from a solution of that metal when touched by zinc. Gas coke, however, recently ignited, or plumbago, placed under similar circumstances, copiously evolves hydrogen from its surface. The same circumstance is noticed with the various forms of porous coke and boxwood charcoal,* but in these cases no gas is given off for some little time. Observing this, it is a matter of great interest to know what became of the gas for the first few seconds, and it directly occurred that the first portions of gas were bound down in a nascent state with the charcoal: this was proved by placing it in a solution of copper, when the charcoal and the coke became coated with a thin film of the metal. In the same way gold, silver, mercury, and lead, were precipitated from their solutions, and iodine set free from iodic acid. Probably the other metals were also precipitated, but their colors render a thin film difficult to be distinguished. When charcoal or the porous coke is made to form the electrodes of a battery, the piece forming the kathode or platinode is found to have similar properties; but the anode or zincode, however, is found to possess nascent

oxygen from its liberating chlorine from muriatic acid, though this is not quite so satisfactory as the experiment with the hydrogen. The gas coke and plumbago are found not to possess the property of retaining the gases. Occasionally charcoal will be found to precipitate gold and silver from their solutions, but in these cases copper, and those metals which have a greater affinity for oxygen, are not reduced.

"View the importance of these experiments, as they demonstratively prove that which has hitherto been the prevailing theory, namely, that nascent hydrogen precipitates the metals, and that the precipitation may take place when the galvanic current is broken; for the coke will retain its hydrogen in some cases for forty-eight or more hours. Now in what state is the hydrogen when it has these properties? Is it in the form of minute bubbles adhering to the surface? This would appear to be a mystery. It is probably in a state analogous to solution; for if a piece of smooth platinum be placed in contact with zinc till minute bubbles are covering its whole surface, and then the zinc be removed and a solution of a metal be poured upon the platinum in such a way that the bubbles are not disturbed, no precipitation takes place; and even spongy platinum or spongy palladium fails under the same circumstances to precipitate the metal.

"Much difficulty arises in naming the two poles of a battery; they are called the positive end and the negative end, the anode and the kathode, the platinode and zincode; now as each pole of a simple battery becomes reversed if the battery is doubled, it is better to name the two ends from the oxygen and hydrogen; since we have shown that the galvanic current owes its power of decomposing many substances entirely to these gases. The names which are proposed are oxode, at which oxygen is evolved, and hydrogode, where the hydrogen is given off.

"The soft and spongy charcoals, as those of deal, possess the property of evolving gas very imperfectly.

"Various kinds of coal, such as anthracite and cannel, were tried, but none were found to evolve hydrogen, nor to have copper precipitated when the circuit was made in a solution of that metal.

"From the above experiments we see that batteries may be constructed of carbon in the place of a negative metal; the hard coke or plumbago answering best, and the porous coke and box-wood charcoal next. These may be used as an ordinary battery with sulphuric acid, but of course a battery thus constructed possesses but little power. If, however, the hydrogen is removed upon Professor Daniell's principle, then will the power be increased, and a charcoal battery may be made of surprising energy. The hydrogen may be removed by metallic solutions, which have a feeble affinity for oxygen, and therefore those of gold, silver, platinum, or copper, would answer best; the latter being the only one in use from its cheapness. The highly oxygenated acids, such as nitric, &c., are more powerful than these, and are now considerably employed; but disadvantages attend their action, for if the current is required to be continued for a long time, a large quantity of acid must be used, and the fumes arising from the battery are injurious to the animal economy: in addition, the strong acid is liable to be spilt over the fingers or clothes; and, lastly, it always transudes through the porous tubes, and acts upon the zinc, even when amalgamated, to a considerable extent.

"It is perhaps worthy of notice, that the powers of the nitric acid battery are not to be attributed to the fluids alone, for no current is formed when platinum is used in both cells. Strong sulphuric acid produced scarcely any action, but the addition of nitric acid rendered it powerful, for a time proportionate to the quantity of the latter acid used. I have tried other substances which have an affinity for hydrogen, such as chlorine, iodine, chloride of lime, peroxide of iron, (or a mixture of muriatic acid and peroxide of manganese,) so that nascent chlorine may be evolved during the action of the battery; but I find that even with the latter, the action, though powerful, is one quarter less than with strong nitric acid.

"A coke battery of two cells, with eight ounces of nitric acid and dilute sulphuric acid, yields ten cubic inches of gas in five minutes. In this case about eight square inches and a half of carbon were exposed, and the communication was effected by means of thick platinum wires. The same quantity of gas was given off from seven square inches of platinum. One piece of charcoal in a single cell gave one-fifth of a cubic inch in twenty minutes.

"Experiments were performed on the properties of selenium, sulphur, phosphorus, bromine, iodine, and chloride; but as nothing very worthy of notice was discovered, it will be unnecessary to dwell upon these substances.

"With regard to the metallic elementary bodies, their properties have been investigated so frequently, and to such an extent, that it may seem unnecessary to draw attention again to them; but two circumstances influencing their action have never been noticed. It is well known that the positive metal should be the most readily acted upon by the solution, and the negative the least, and the further these are apart, the more forcible will be the battery; thus, *cæteris paribus*, platinum and zinc are more powerful than iron and zinc; but if a circuit be made of a piece of smooth platinum and zinc, it will sometimes happen that the effect is less than when a circuit is formed by a similar piece of iron. Now this appears at first sight paradoxical, though it can in many instances be easily explained; for if the platinum be carefully examined, it will be seen that the acid solution does not really wet the platinum, but runs off from the greater part of the surface, as metallic mercury does from glass. In this state, a piece of platinum, having a surface of thirty-two square inches, formed into a battery with amalgamated zinc and connected with a magnet, supported three-quarters of a pound through five thicknesses of paper: when the same piece of platinum was heated or dipped in nitric acid, and afterwards well washed, it supported a similar weight through twelve thicknesses of paper, thus being less powerful than iron in the first instance, and more so in the second. In the same way, silver supported under the like circumstances, the keeper of a magnet through three layers of paper: on being heated and again wetted, the attractive force was exerted through nine thicknesses of paper, but no additional power was gained by removing the surface of the silver by nitric acid. The metals in these cases appear to become coated with a film of air, which effectually prevents the contact of the fluid. This is also seen in the various forms of charcoal, which after ignition are very powerful, but lose much of their force if long exposed to the air; their energy, however, is restored upon their being again heated."

PLANTS IN LIVING ROOMS.

VERY much has been said about plants in windows, some asserting their tendency to injure health, and others the contrary. There is one point, however, in which I think all will agree, and that is, their beautiful appearance. Whether in the splendid halls and drawing-rooms of the wealthy, or in the humble cottage of the poor, there can be but one opinion respecting their appearance. What artificial splendour can compete with a number of handsome flowering plants in the windows of our rooms? Certainly none. Their beautiful green leaves, contrasted with their blossoms of various forms and colors, present an appearance altogether beyond the reach of art; and during the winter months, when the ground is covered with snow, and the gardens present an appearance more of desolation than of beauty, the trees all leafless, and the flowers cut down by the frost, *then* what a feast is presented by flowers blooming away in your house, (heedless of the chilling blasts without,) enlivening the dreariness of winter, spreading an odoriferous perfume through your apartments, and rivalling in beauty many of those tender kinds, who only delight us with their fragrant flowers during the genial summer weather, not able to bear up against the chilling and frosty air of winter. With regard to the choice of flowers for windows, of course, that is a matter of taste; but for the cottager, I think, he will find the Fuchsia, Hydrangea, Chinese Primrose, Cactus speciosa, and Monthly Roses, to be not only cheap, but elegant additions to his apartments.

We will now proceed to consider the principal question on the subject, viz.: are they beneficial or injurious to health? and I shall endeavour to show clearly and upon philosophical principles, that in *moderate quantities* they are *decidedly healthy.* Our atmosphere is simply a mixture of oxygen, or vital air, (so called because no animal can live without it,) and nitrogen, (called also azotic gas, because it would immediately deprive any one of life, who was to breathe it) with an exceedingly small quantity (about 1 part in 1000) of carbonic acid gas, which is also poisonous, and of course, several adventitious substances, such as watery vapour, &c. Now, in breathing this atmospheric air, man, and all other animals, retain the oxygen which enters into the blood, and return the nitrogen, which being lighter than the air, ascends and waits for fresh combinations; thus man deprives the air of its constituent which supports life, and returns the poisonous part; on the contrary, plants (not flowers only, but plants generally,) give out during the day a large quantity of oxygen, which combining with the nitrogen which man exhales, *preserves the equilibrium* and *reforms atmospheric air.* Here, then, we see that "the plant purifies what the animal had poisoned." The loss of the vast quantity of oxygen which is absorbed by the breathing of animals, would soon render the air totally unfit for use, if the Almighty Framer of the universe had not in his infinite wisdom appointed an antidote in the vegetable creation. This is, I think, a sufficient evidence, that plants in rooms are *decidedly healthy*, but when I state this, I must also assert, that IN *bed-rooms they are exceedingly deleterious*, as during the *night*, many plants give out carbon instead of oxygen, and by that means instead of purifying the air *help to poison it.* The fact that man exhales air unfit for being re-breathed, is too clear and generally admitted, to need an experiment; but perhaps it may be as well to mention one, as some readers of this article may be sceptical on this point, to show that, during the day, plants give out oxygen; I therefore select the following from Parke's Rudiments of Chemistry:—"Invert a glass bell full of water in a flat dish of water, and introduce leaves under it. Expose the apparatus to the sun's rays and very pure oxygen gas will be disengaged, which will displace the water in the glass and occupy its place." In like manner, a sprig of mint corked in a small portion of carbonic acid gas, will render it capable of supporting life. Thinking, as one of our present authors writes, that "*Floriculture is amongst the most innocent and humanising of all pleasures,*" and that "*every thing which tends to diffuse such pursuits amongst those who have too few amusements, is a point gained for happiness and for virtue,*" I consider it a duty which I, as a Floriculturist, owe to my favourite recreation, to endeavour to remove that prejudice which so generally exists against flowers in windows, by showing, that *(except in sleeping apartments)* it is destitute of foundation; and further, by proving on chemical and philosophical principles, that they are not only *interesting* and *beautiful*, but *actually conduce to the salubrity of the atmosphere.*

On purchasing Plants.—Those who are fond of having plants in their windows are often disappointed in their wishes, by the want of a little knowledge and a little care; for though the plants which they purchase appear in fine condition when purchased, they frequently begin to fall off at the very time when they ought to come into full flower. One obvious cause of this is, the different circumstances they are placed under by the purchaser, to what they had been in when in possession of the nurseryman; and still more, the very different management to which they are subjected.

In purchasing flowers in pots, it is important to recollect, that by far the greater number of them have been forced into a premature display of their beauties by artificial heat and shelter, which renders them full of sap and tender, from the branches and shoots not being ripened. The color of their leaves is of a peculiar shade of green, which from the abundance of their juices, appears not unhealthy; but though it may appear fresh, it is *much paler than plants which have grown in the open air* and exposed to the variations of the weather. Another important circumstance is, that the nurseryman's green-house always has light perpendicular, as well as on both sides, so that his plants grow upright, and send out branches on all sides, forming what is termed a well-balanced head.

Now when a plant which has been thus reared is transferred to the inside of a room window, or to a flower-stand in a sitting-room, it is at once deprived of its customary perpendicular light from the roof of the green-house, as well as two, if not three, of its side lights; that is, it only receives light on one side, to which it will soon bend, till its upright growth is spoiled, and the balance of the head is destroyed by the branches receiving the front light far outgrowing those which are behind them. When this is first observed, the bending of the plant is attempted to be corrected by turning the back part to the front; but this, so far from answering the purpose, not only gives the branches unsightly curves and twists, but *greatly weakens the plant.* It is much better to let the tendency of the boughs to the light operate always in the same direction, *till the whole assume the spread, fan-like position*

which is the only natural one for window plants having no perpendicular light—it being impossible in such cases to grow plants with well-balanced heads.

It is also very important, on purchasing plants in pots, at first not to expose them out of doors, either all night or to bright sunshine. The cold of our nights, even far in the summer, will often injure, if it do not kill, plants not gradually inured to it: while the bright sunlight of a summer's day will often wither or kill plants which have previously had only the tempered light of a green-house.

With respect to watering, in cool moist weather it is very generally overdone, and the plants are rendered dropsical and sickly, by having the mould always soaking wet; whereas, in dry summer weather, they are as generally under-watered,—for in *such weather, the effects of one watering, particularly in small pots, and more so when these are new and porous, will disappear in a few hours.* Many plants, in such circumstances, would require to be watered *at least twice, if not thrice a day.* The greatest care ought always to be taken to have the pots so drained with broken potsherds, as that no water may stagnate, and for this reason all pans with standing water in them should be prohibited. —*Floral Calendar.*

MISCELLANIES.

Interesting Example of Electrical Attraction.—It is probably known to many persons, that, in the process of applying gold-leaf in gilding the frames of pictures and looking glasses, the frame, after being duly prepared by a composition which is laid on with a brush, is moistened with gin or some other spirit. The gold-leaf, cut up by a round-edged knife into pieces of a suitable size, is taken up on a flat hair-brush and brought with the gold downward very near to the place to which it is to be applied. When it comes within a short distance, generally about half or three-quarters of an inch, without any farther attention of the artist, it suddenly flies from the hair-brush to the surface on which it is to be laid, and clings to it and embraces it with such delicacy as to cover every roughness. The gold, apparently, makes just such an effort, as it does when attracted in the gold leaf electrometer, and it appears to arise from the same cause, namely, an electrical attraction. This attraction is obviously produced by the evaporation of the spirit. Evaporation is well known to produce electrical excitement, and to generate opposite states of electricity in the contiguous bodies. We should therefore expect the attraction to be the strongest in the case of those bodies which evaporate most readily—accordingly the gold leaf is less powerfully attracted when water is substituted for spirit. The success of the gilder appears, in these cases, to depend very much on the exertion of a principle which he is very little aware of. It would seem, that but for this, it would be scarcely possible to apply the leaf with entire precision, to all the variety of surface produced by the carver. We have thought it worth while mentioning, as a happy illustration of a scientific principle occurring in the arts.

Pumpkin Sugar.—Some rural landholders in the neighbourhood of Presburgh have just tried to make pumpkin sugar, and the experiment has completely succeeded. Twenty-seven quintals of that vegetable yields one quintal of raw sugar. This invention is one of great importance to Hungary, whose soil is very favorable to the cultivation of pumpkins, which attain here so large a size that some of them are to be found weighing four hundred pounds.—*German Paper.*

Garden Pots.—A patent has been taken out for a garden pot. In appearance it is like a common one, but it has an outer or second side, by which an intermediate space is formed for the supply of water; which, on account of the porous nature of the material used in the manufacture, gradually filters through the inner pot, and yields to the flowers or shrubs therein planted a continued and uniform supply.

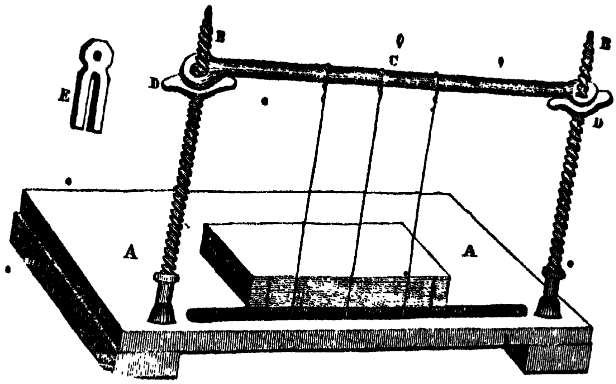
Dry Rot.—Chance, which often gives valuable information to observers, has pointed out a preventive of the rot in timber, that, while it promises to be efficacious, has, at the same time, cheapness to recommend its employment. It has been found that the timber used about the copperas works in Whitstable, in Kent, has continued in a sound state for many years, which the seafaring people of that place attribute to its being soaked in the liquor that runs from the copperas-stones, and are unanimous in thinking this would prove a complete preventive of dry rot; there is a greater reason to hope for a good effect from this, as the copperas liquor, by its sulphuric acid, has a decided action on every part of timber, somewhat analogous to that which charring has on its surface, by which it has been long known to be preserved where it would otherwise have decayed rapidly.

India Rubber Hats.—An American paper, the "Portland Courier," says, that a manufacturer at Portland has succeeded in making very good hats from Indian-rubber. They are, it adds, very light, weighing, on an average, about four ounces, and are so elastic that they may be folded like a handkerchief—may be crushed into any shape, and will immediately return to their original form without being injured in the smallest degree. They may be folded in a trunk by the traveller, and at the end of the longest journey can be restored to shape without any difficulty, and without sustaining any injury.

To Fix Black-lead Pencil Drawings.—Dissolve a small quantity of isinglass, and dilute it with warm water, till so thin that when spread upon paper, and dry, it shall be free from those sparkling particles which never fail to appear, if too thick. Take a broad flat camel-hair pencil, set in tin, and fill it plentifully with the solution, and draw it slightly over the work, intended to be fixed, once or twice, or according as the size of the picture may require: it must be very carefully done, to prevent disturbing the sharpness of the pencil work; when dry, it will be found to resist the effect of Indian-rubber. It is advantageous to sponge the back of the paper or Bristol board before applying the solution, in order that the paper may dry level, as it is apt to contract round the edges when only one side is wet. If there be a margin round the drawing, it is not requisite to sponge the back. Milk and water answers the above purpose quite as well—so does alum water.

Liquid True Blue.—Take half a pound of best double oil of vitriol, mix one ounce of Spanish indigo, (first pound the indigo very fine,) and scrape in a little chalk; have a large iron pot half full of sand, which set on the fire—when the sand is hot, put the bottle in and let the vitriol, &c. boil gently for a quarter of an hour—take the whole off the fire and let it stand for twenty-four hours, and then bottle it for use.

Fig. 1.



BOOKBINDING

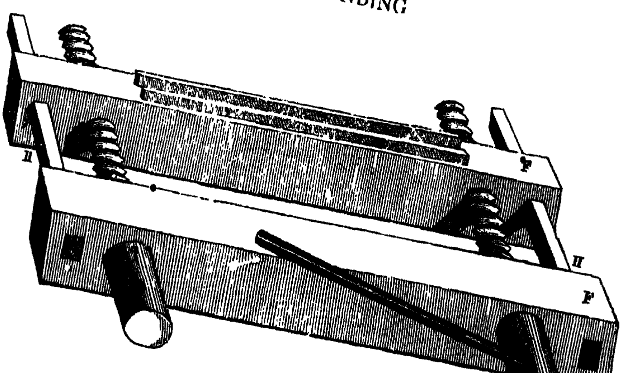
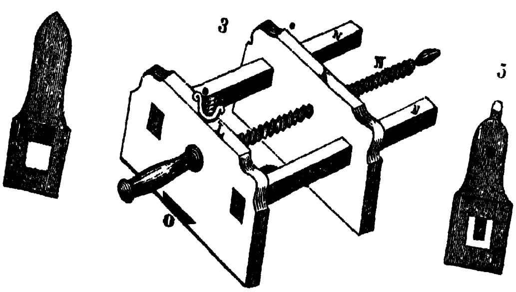


Fig. 2.



BOOKBINDING

Is the art of securing together a number of separate leaves into one book, and is of very great antiquity, the invention being generally attributed to one of the kings of Pergamus, to whom we are also said to be indebted for the invention of parchment. Bookbinding, properly so called, includes the binding of all printed books; while vellum-binding is the term applied to the binding of every description of account books. The two branches are quite distinct, and seldom, if ever, successfully practised by the same individual; we shall, therefore, describe each branch separately, beginning with bookbinding.

In binding printed books, they are generally received by the binder in sheets, which are folded into quartos, octavos, duodecimos, &c. as the case may be. This process is assisted by certain catchmarks or signatures, printed at the bottom of each sheet, by attending to which, and keeping the folio of one page on the folio of another, and at the same time preserving the necessary correspondence between the foot of each page, the work will be properly folded, and an uniformity of margin preserved throughout the work. The book having been folded and pressed, is next beaten on a large smooth stone, with a cast iron bell-shaped hammer, weighing from twelve to fourteen pounds. This beating requires great care and skilfulness on the part of the workman, and various attempts have been made, at different periods, to supersede the process, by the use of hydraulic and other powerful presses; these, however, have proved unfit for the purpose, generally creasing and disfiguring the work. Mr. Burn, of Hatton Garden, has, however, succeeded in rendering books extremely compact and solid, by passing the sheets, when folded, between a pair of powerful rollers; and this method will eventually supersede the old laborious and imperfect one of hammer-beating. The apparatus of Mr. Burn consists of two iron cylinders, about twelve inches in diameter, adjustable in the usual manner by screws, and worked by manual labour applied to one or two cranked handles. A boy sits in front of the press, who gathers the sheets into packets by placing two or more upon a piece of tin plate of the same size, and covering them with another piece, and thus proceeding, by alternating tin plates and bundles of sheets, till a sufficient quantity have been put together, which will depend greatly on the thickness and hardness of the paper, &c. The packet so formed is then passed between the rollers, and is received by the man who turns the winch, and who has time to lay the sheets on one side, and hand over the tin plates, by the time that the boy has prepared a second packet. The time occupied in this process is about one-twentieth of that requisite for beating. It is not merely a saving of time, however, that is gained by using the rolling-press, for the paper is rendered much smoother, and the compression of the book is one-sixth greater than could have been obtained by beating. The Society of Arts presented Mr. Burn with their silver Vulcan medal for his invention, which is now in very general and extensive use. Newly printed works will not admit of beating or rolling, and books which are only to be boarded, do not require more than a good pressing. After beating or rolling, the book is collated, and the plates (if any) put in their respective places. It is then put in the standing press, and after remaining there a short time, is taken out, and the waste leaves added at the beginning and end. The book is then taken up between the extended fingers of each hand, and the back and head knocked up nice and square; one side of the book is then laid upon a pressing board as large as the book itself, beyond which the back must project about half an inch; a second pressing-board, corresponding in size and position with the former, is placed upon the upper side, and the board being firmly grasped with the left hand, the book is lowered into the cutting-press, which is screwed up tight, and a certain number of grooves, according to the size of the book, are cut in the back with a tenon saw, for the reception of the cords on which the book is to be sewed. After sawing, the sections are parted by passing a folding stick up and down between them. The book is then taken to the sewing-press, of which Fig. 1 is a representation. It consists of a stout flat board A A, and two upright screws B B, with a long opening between them. A top rail C rises and falls upon the screws by means of two nuts D D. Several cords, suited in size and number to the kind of books which are to be sewn, are attached to the rail C, and set to correspond with the sawed grooves in the back of the book; the cords being carried down through the aperture in the bed of the press, are fastened underneath by means of brass keys, of which E is a representation. The number and distances of the bands are quite arbitrary, and are disposed according to the fancy of the workman; it may, however, in general, be regulated as follows: 32mos. three bands; 18mos., 12mos., 8vos., and two-leaf 4tos. four bands; royal 8vos. and whole-sheet 4tos. five bands; and folios from five to seven bands. In sawing the back two extra grooves are made, one at each end of the book, for the catch or kettle-stitch. The book being placed with the back towards the sewer, and the title uppermost, the fly-leaf or end paper is first laid upon the press and sewed to the cords, by passing the needle in the first right-hand groove or catch-stitch mark, with the right hand; the left hand being kept in the middle of the section, receives the needle and draws it through, leaving two or three inches of the thread undrawn. The needle is then returned out on the head side of the band, received by the right hand, and passed through on the other side of the band, by which the thread is conducted round each band in succession. The needle being carried along the inside of the section, and led round each band in this manner, is at last brought out of the last groove or left hand catch-stitch mark. The first section of the book is then taken and sewed to the bands in the same way; when the needle comes out at the catch-stitch mark, over the end of the thread left out of the fly-leaf in the first sewing, the thread is tied to it in a knot. The remaining sections are then sewn, the thread being fastened through the catch-stitch of each preceding section. Care must be taken not to draw the thread of the catch-stitches too tight, but to keep the back equally swelled. A number of books may be sewed one on another till the press is three parts full, care being taken to finish off the sewing of each book, and not to catch-stitch them together. The proper number of books being sewed, the strings are cut from the rail, and unfastened at the bottom; the books are then separated, and the bands cut apart, leaving about two inches on each side of the book. After sewing, the back of the book is glued; and when that is dry, the ends of the bands are opened and scraped. If the book is to be lined, which is customary with all half-extra

and other superior work, it is now done, either with fine colored or marble paper. If with marble paper, the sheet is folded with the plain side outwards, one half of it being pasted; it is laid between the fly-leaves, into the fold of which it is closely worked; the other half is then pasted, and the next fly-leaf rubbed down upon it, any superfluous edges being cut off with the shears. This done, the back is next to be rounded, which is effected by laying the book on the press cheek, with the fore-edge towards the workman, who presses the fingers of his left hand upon the book, and at the same time draws it towards him, gently tapping the back up and down with a hammer, alternately changing the sides until the book is uniformly and effectually rounded. The back is then squeezed in the cutting press for a few minutes, which sets it, and the book is then ready for *backing*. This consists in forming a projection of the back on each side of the book, sufficient to cover the boards, and is done by placing cutting boards on each side of the book, within about a quarter of an inch of the back, or according to the size of the book, care being taken that the boards are parallel with the back, and at equal distances from it. The boards being tightly grasped by the left hand are lowered into the cutting-press, and screwed tight. The back is then hammered gently and uniformly all over, which causes it to spread over the boards so as to form the required ledge or projection. If any roughness appears on the back, it is removed by scraping, and cleaned off with paste and paper shavings. The boards for the cover, which are brown milled boards, having been cut to the required size with shears, or ploughed in the cutting-press, two holes are pricked with a bodkin for each band, one of them directly opposite the band, the other about an inch beyond it. The first, for 8vo., should be about half an inch from the edge of the board, the others about an inch, or for larger works still forwarder. The bands are then drawn through the outer side of the board, and passed through the other hole to the outside again, where the ends are spread and pasted. Each board is then opened, and laid separately on a smooth piece of iron, and the strings hammered flat. The boards, which should not be put on too tightly, having been properly adjusted, and the back examined to see that it has not been deranged, and the defects, if any, remedied with the backing hammer, the next step is cutting the fore-edge. For this purpose the boards are thrown out of the grooves, or ledges, and then brought to a perfect level with the back by knocking on the cheeks of the press; a *cutting-board*, of oak or beech, and rather wedge-shaped, is then placed on the left hand of the book, and another, called a *runner*, on the right; the whole is then placed in the cutting-press, Fig. 2, the runner being brought even with the right cheek of the press, and when properly adjusted, the press is screwed up, and the fore-edge ploughed. After cutting the fore-edge, the book is taken out, and the back rounded as before, when a corresponding groove will be formed in the front. The head is next cut by knocking the boards straight up with it, keeping them in the ledge produced by backing; the cutting-board and runner are then applied as before, and the head ploughed. For cutting the opposite end, the boards are slipped below the head as much again as it is intended they shall project, which should be rather less than on the fore-edge. A small piece is then taken off the inner corner of each board, and the boards being replaced, there will be found a sufficient projection for both ends.

The cutting-press, Fig. 2, which has been referred to, consists of two wooden cheeks, F F, connected by two slide bars H H, and two wooden screws I I. Upon one of the cheeks F F are two guides for the plough to work in.

The plough, Fig. 3, which is the cutting instrument, consists of two sides, K L, connected by a screw M, and two slide bars, N N. A knife, Fig. 4, is fastened to the under side of the cheek L, by a strong square bolt, which takes into a groove cut on the circumference of the screw M, and prevents it from moving laterally in the check. When the screw is turned, therefore, the two sides of the plough approach to or recede from each other.

Various attempts have at different times been made to improve the cutting-press and its appurtenances. Mr. Baxter, of Lewes, proposed to obviate most of the inconveniences attending the use of the common plough-knife. His improved knife consisted of a brass or gun-metal stock, Fig. 5, having a dove-tailed groove on its under surface, in which slides a steel blade or cutter, which is kept in any required position by a set screw on the upper part of the stock. The great advantage of this knife is, that when once properly adjusted, the blade may be changed and ground *ad infinitum*, without deranging the adjustment of the stock.

(To be continued.)

BIDDERY WARE.

SEVERAL alloys of metal are used in the East Indies, which might be advantageously employed in Europe for particular purposes, and thus open new resources to our manufacturers.

Biddery is a large city in the East Indies, 60 miles N. W. of Hyderabad, and has given its name to a particular species of metallic ware, which is much used in that country. It is of a black color; and as it never fades, and when tarnished may be easily made to look as if new, might certainly be used more advantageously for the formation of ink-stands, and some similar articles which are liable to become spotted with ink, than the brown bronze now in use for the finer articles of that description: and it would be less liable to break than either the black Wedgewood or glass ink-stands.

The Biddery ware manufactured at that place, is made by adding 24 lbs. of tin to 1 lb. of copper in a melted state. The mixed metal is, of course, in this stage of a white color, and is made into the required form by the usual method used in casting small articles. The article being cast, and, if necessary dressed, it is then scraped with a knife, and colored of a lasting black color, in the most simple manner possible. Equal parts of sal-ammoniac in powder, and of the reddish saltpetre earth found in the neighbourhood of Biddery, are made into a paste with a little water, and rubbed on the metal, which instantaneously assumes a lasting black color. Sometimes, indeed, this ware gets a little tarnished, and acquires a brownish color; but the fine sable hue is immediately restored on the article being merely rubbed with a little oil or butter.

For Indian use, the articles made of this ware are inlaid with silver or gold-leaf, but more commonly the former, which affords the best contrast with the black ware. The intended figure is cut out in leaf silver, and placed on a bit of earthen.

ware before the artist, who, with a pointed tool, engraves the same figure on the article, then applies the leaf silver, and gently hammers it into its place.

In some other places of India, they melt together 16 oz. of copper, 4 oz. of lead, and 2 oz. of tin; and having poured out this metal into ingots, they then melt 3 oz. of this mixed metal with 16 oz. of spelter, and cast their articles in the usual way.

As the saltpetre earth contains not only saltpetre, but also common salt; so, in places where it cannot be procured, the articles are washed with a solution of 1 oz. of sal-ammoniac, a quarter of an ounce of saltpetre, another quarter of an ounce of common salt, and the fifth part of an ounce of blue vitriol; which last might probably be omitted.

COMPARISON BETWEEN THE LIGHT OF CANDLES, LAMPS, AND GAS.

Previously to the use of coal gas being introduced, the principal modes of procuring artificial light consisted in the production of flame by the combustion of animal or vegetable oil, wax, or some combustible mineral substance. But the means most generally employed were oil lamps, and wax or tallow candles. Many schemes were devised for increasing their quantity of light, as well as lessening the expense of its production, and also for obviating their attendant inconveniences. All these being considerations of importance, a short notice of the more remarkable circumstances relating to them may not be uninteresting.

Lamps and candles require the employment of a wick composed of some combustible material, which, being inflamed, assists in volatilizing the oil, tallow, or wax, and likewise in conveying it to the flame, in order that its continued combustion may be effected so as to produce a constant stream of light. But when light is obtained by means of an oil lamp, there are some circumstances which require particular attention. It is requisite that the quality of the oil should be such that it may be readily inflamed; and it should be deprived of those substances which may tend to produce an offensive odour, or to obstruct its ascent in the wick. The obvious purpose of the wick is the conveyance of the oil by means of capillary attraction to the part of the wick which is lighted, so that the high temperature of the flame may occasion its combustion. Hence the constant decomposing and consuming of the oil produces a continued current to support the flame. The nature of the combustible material which constitutes the wick, as well as its structure, are also important considerations; for it is essential that the fibres should readily transmit the fluid to its place of combustion; and a difference is observable in the flame derived from a wick of cotton and that proceeding from a rush.

It is of great importance in all the processes of combustion, that the access of air to the ignited body should be free; for if the flame be not adequately supplied with air, a part of the combustible matter escapes in the form of smoke, from not being decomposed. When oil is burnt in a lamp with a very slender wick, it is observable, that although the flame is small, it is a brilliant white; but in proportion as the wick is larger, the combustion is less complete, and the flame appears to be brown. Moreover, when a very large wick is employed, the flame to a certain extent is not only brown, but the lower internal part of it has a dark color, which seems to arise from a portion of the volatile matter not becoming ignited.

The great difference in the intensity of the light derived from a flame, according as it is supplied with a greater or less portion of air, may be seen by placing a lamp with a small wick under a shade or funnel of glass which is not perfectly closed at the top, and more or less closed at the bottom. The flame will appear white as long as the current of air is allowed to pass freely through the funnel; but in proportion as the aperture is diminished, the flame will become brown, and it also lengthens, wavers, and is smoky; however, the whiteness of the flame is instantly restored on the opening being enlarged so as to permit a free current of air to come in contact with it.

The inconvenience attendant upon the use of a thick wick having often been noticed, the attempts to obviate it have been various; in some of them a number of small wicks were substituted for the larger; and in others they were made *flat*, instead of *cylindrical*. But the plan adopted in the Argand lamp was the most scientific, and far surpassed any previously introduced. In this, as the cotton wick forms a hollow cylinder, when it is lighted its flame is hollow, and is supplied from the bottom of the cylinder with a current of air, which comes into contact with both its inner and outer surfaces; and the glass funnel surrounding the flame, not only tends to preserve it steady, but it also serves, in a certain degree, to regulate and quicken the current of the air. The utility of this ingenious contrivance for a variety of experimental purposes will be obvious from the facility of moving its wick upwards and downwards; by raising the wick, it exhibits the disadvantage attendant upon a long one, which supplies more oil than the volume of flame is capable of consuming, and therefore produces smoke; on the contrary, by lowering the wick and lessening the supply of combustible matter, the flame is proportionably diminished, which shews the effect of a short wick in this process of combustion. This is one of the advantages which attends the use of this kind of lamp; but in all others, when the wick is once adjusted to its proper height, the flame continues nearly the same for a considerable time. However, as the combustible material employed in a lamp, being a fluid, requires a proper vessel to contain it, the oil is liable to be spilled; and, besides, from imperfection in the workmanship, or from accident, the vessel may become leaky, and these are inconveniences which the use of gas has a tendency to obviate.

With regard to candles, the wax or tallow of which they are composed being in a concrete state, remains so till the wick is ignited, when the heat of the flame, by melting a small portion of the combustible substance, forms a cup, whence the fluid matter readily ascends to the ignited part of the wick, to become volatilized and inflamed, and hence the combustion is continued through the whole length of the candle. But the brilliance of the flame depends, in some respects, upon the diameter of the wick, and this is also regulated by the fusibility of the material to be consumed. For instance, a wax candle, being less fusible than one of tallow, allows, in proportion to its bulk, the use of a smaller wick for its perfect combustion in order to afford a clear flame; besides, from the small size of the wick, its upper extremity readily comes into contact with the external air, which occasions it to be com-

pletely burnt, and as it becomes converted into white ashes, it bends on one side so as to render snuffing it unnecessary. The case is different with respect to tallow candles; for, as the tallow readily melts, it is rapidly volatilized, and a considerble portion of it escapes without being properly burnt. The rapid flow of the fluid and imperfect combustion of the gaseous matter, occasions a spongy kind of substance to be deposited at the upper part of the wick, and as its bulk increases it prevents the air from properly mixing with the flame; of course the light is gradually diminished, and hence the necessity of frequently snuffing tallow candles.

The following statements will not only elucidate the comparative advantages of different kinds of lights, but even the same kind of lights under different circumstances. Count Rumford stated, as the general result of his experiments, that a common Argand lamp afforded the quantity of light equal to nine good wax candles; and that when his Argand lamp was burning with its greatest brilliancy, it gave twelve times as much light as a good wax candle ⅞ of an inch diameter, but never more. He also observed the light of a wax candle to vary during one hour from 100 to 60, and it was occasionally snuffed. But he found the variation in the quantity of light produced by an ordinary tallow candle to be much greater: when it had been just snuffed and was burning at its greatest brilliance, its light was as 100; in eleven minutes afterwards it was but as 39; when eight minutes more had elapsed it was reduced to 23; and in ten minutes more, or in twenty-nine after it had been last snuffed, its light was only 16. However, upon its being again snuffed, it recovered its original brilliance, 100. He also made various experiments to ascertain the relative expense of different inflammable substances for the production of light; and the results were, that a good wax candle, properly snuffed and burning with a clear bright flame, consumed 100 parts in weight; a good tallow candle burning under the same circumstances consumed 101; but a similar tallow candle burning very dim from the want of snuffing consumed 229, so that the consumption of more than double the quantity of combustible matter yielded less light. This latter circumstance proves the advantage of snuffing candles frequently, both as regards the quantity of light, and the economy of the practice.

The preceding experiments of Count Rumford show that it is more economical to burn an Argand than a common lamp; and the following statement of Mr. Creighton exhibits the comparative expense of an equal quantity of light from different substances. He estimates twenty cubic feet of coal gas, or ten of oil gas, as equivalent to a pound of tallow, and 5000 grains of good spermaceti oil as equal to 7000 grains, or 1 lb. avoirdupois, of tallow.

	s.	d.
Valuing the quantity of light afforded by 1 lb. of tallow in candles, at	1	0
An equal quantity of light from spermaceti oil consumed in an Argand lamp will cost	0	6
An equal quantity of light from whale oil gas	0	4½
An equal quantity of light from coal gas ..	0	2¾

This estimate is made upon the criterion of half a foot of coal gas per hour being burnt to give a light equivalent to one mould candle of six in the pound; but he observes, that when burnt under favorable circumstances, the quantity of gas consumed did not exceed one-third of a cubic foot for each candle, and in some experiments not more than one-fourth, which would of course reduce the expense of gas in proportion.

Mr. Anderson, of Perth, states, that he very carefully made a great number of experiments with a view to determine the comparative quantity of light afforded by candles and coal gas. The size of the candles which he employed was short sixes, and he gives the following table of the results. The first column shows the kind of burners; second, the number of cubic inches of gas consumed per hour; third, the number of candles to which the light is equal, as determined by the method of shadows; fourth, the number of cubic inches per hour, corresponding to the light of one candle.—A cubic foot contains 1728 inches.

3 Jet	2074	6	346
Argand, 5 holes	2592	8	324
Do. 10 do.	3798	12	316½
Do. 14 do.	5940	19¼	308
Do. 18 do.	6804	21	324

The mean of these results is, that 323¼ cubic inches of coal gas yield light equal to that of one candle for one hour; but this is the coal gas of Perth, which he stated to possess a very great illuminating power. With regard to the superior light of oil gas, the results of experiments have varied, and of course opinions have been different; but the general conclusion is, that taking the illuminating power of coal gas as 1, that of oil gas may be stated as from 1½ to 2, varying according to its specific gravity, which differs from 750 to 1000; and though coal gas is generally more uniform in this respect, it varies according to the quality of the coal and other circumstances.

But the advantages of gas-lights are peculiarly obvious in their resplendent effect in the public streets; and they form a striking contrast to the dreary glimmerings of the oil lamps which were formerly employed, and are even now in some places used. Though great and various have been the improvements introduced into their construction, and with all the aid afforded by reflectors of various kinds, how ineffective and gloomy are even the best of them when compared with the light emanating from coal gas. Besides, considering the quantity of light in proportion to the expense, it must be admitted to be by far the most economical for public purposes; for, according to the statements of those who are best informed upon this subject, the gas companies of the metropolis supply 1000 cubic feet of coal gas to a public lamp for the trivial sum of five shillings.

BEES' WAX.

Wax is the substance which forms the cells of bees. It was long supposed to be derived from the pollen of plants, swallowed by these insects, and merely voided under this new form; but it has been proved by the experiments, first of Mr. Hunter, and more especially of M. Huber, to be the peculiar secretion of a certain organ, which forms a part of the small sacs, situated on the sides of the median line of the abdomen of the bee. On raising the lower segments of the abdomen, these sacs may be observed, as also scales or spangles of wax, arranged in pairs upon each segment. There are none, however,

under the rings of the males and the queen. Each individual has only eight wax sacs, or pouches; for the first and the last ring are not provided with them. M. Huber satisfied himself by precise experiments that bees, though fed with honey, or sugar alone, produced nevertheless a very considerable quantity of wax; thus proving that they were not mere collectors of this substance from the vegetable kingdom. The pollen of plants serves for the nourishment of the larvæ.

But wax exists also as a vegetable product, and may, in this point of view, be regarded as a concrete fixed oil. It forms a part of the green fecula of many plants, particularly of the cabbage; it may be extracted from the pollen of most flowers; as also from the skins of plums, and many stone fruits. It constitutes a varnish upon the upper surface of the leaves of many trees, and it has been observed in the juice of the *cow-tree*. The berries of the *Myrica angustifolia*, *latifolia*, as well as the *cerifera*, afford abundance of wax.

Bees' wax, as obtained by washing and melting the comb, is yellow. It has a peculiar smell resembling honey, and derived from it, for the cells in which no honey has been deposited, yield a scentless white wax. Wax is freed from its impurities, and bleached, by melting it with hot water or steam, in a tinned copper or wooden vessel, letting it settle, running off the supernatant oily-looking liquid into an oblong trough with a line of holes in its bottom, so as to distribute it upon horizontal wooden cylinders, made to revolve half immersed in cold water, and then exposing the thin ribbons or films thus obtained to the blanching action of air, light, and moisture. For this purpose, the ribbons are laid upon long webs of canvas stretched horizontally between standards, two feet above the surface of a sheltered field, having a free exposure to the sunbeams. Here they are frequently turned over, then covered by nets to prevent their being blown away by winds, and watered from time to time, like linen upon the grass field in the old method of bleaching. Whenever the color of the wax seems stationary, it is collected, re-melted, and thrown again into ribbons upon the wet cylinder, in order to expose new surfaces to the blanching operation. By several repetitions of these processes, if the weather proves favorable, the wax eventually loses its yellow tint entirely, and becomes fit for forming white candles. If it be finished under rain, it will become grey on keeping, and also lose in weight.

In France, where the purification of wax is a considerable object of manufacture, about four ounces of cream of tartar, or alum, are added to the water in the first melting-copper, and the solution is incorporated with the wax by diligent manipulation. The whole is left at rest for some time, and then the supernatant wax is run off into a settling cistern, whence it is discharged by a stop-cock or tap, over the wooden cylinder revolving at the surface of a large water-cistern, kept cool by passing a stream continually through it.

The bleached wax is finally melted, strained through silk sieves, and then run into circular cavities in a moistened table, to be cast or moulded into thin pieces, weighing from two to three ounces each, and three or four inches in diameter.

Neither chlorine, nor even the chlorides of lime and alkalis, can be employed with any advantage to bleach wax, because they render it brittle, and impair its burning quality.

Wax purified, as above, is white and translucent in thin segments; it has neither taste nor smell; it has a specific gravity of from 0·960 to 0·966; it does not liquefy till it be heated to 154½° Fah.; but it softens at 86°, becoming so plastic, that it may be moulded by the hand into any form. At 32° it is hard and brittle.

It is not a simple substance, but consists of two species of wax, which may be easily separated by boiling alcohol. The resulting solution deposits, on cooling, the waxy body called *cerine*. The undissolved wax, being once and again treated with boiling alcohol, finally affords from 70 to 90 per cent. of its weight of cerine. The insoluble residuum is the *myricine* of Dr. John, so called because it exists in a much larger proportion in the wax of the *Myrica cerifera*. It is greatly denser than wax, being of the same specific gravity as water; and may be distilled without decomposition, which cerine undergoes.

Wax is adulterated sometimes with starch; a fraud easily detected by oil of turpentine, which dissolves the former, and leaves the latter substance; and more frequently with mutton suet. This fraud may be discovered by dry distillation; for wax does not thereby afford, like tallow, sebaic acid (benzoic), which is known by its occasioning a precipitate in a solution of acetate of lead. It is said that two per cent. of tallow may be discovered in this way.

ON DEAD LIME.

It has long been observed by lime-burners, that if lime-stone is imperfectly burnt in the first instance, no further exposure of it to fire will produce quick lime; but the philosophical chemists have doubted the truth of this observation. Mr. Vicat, however, in a work he has lately published upon mortar and stucco, has confirmed the observation of the lime-burners.

He found that, in making quick lime in a small furnace, if the small pieces of lime-stone which fell through the grate into the ash-pit, before they were thoroughly burnt, were collected and put again into the fire, even for several successive times, quick lime was not obtained, but a kind of lime technically called dead lime, which will not slake with water; but which, on being ground and made into a paste with water, differs from common mortar by setting under water.

When chalk is burnt, and the lime left to fall into powder by long exposure to the air, and then made into a stiff paste with water, it sets very sensibly under water; so that the action of the air seems to produce a dead lime, similar to that produced by the incomplete burning of lime-stone, as being neither pure quick lime, nor a complete carbonate of lime, but a kind of subcarbonate, which possesses the new and useful property of setting under water.

Mr. Raucourt de Charleville observed the same effects to be produced as are described by Mr. Vicat. He also made another observation respecting the production of a cement which sets under water. He had prepared a mixture of quick lime and clay, and left it to dry; some of this was then broken into small pieces, and burnt on a heated cast iron plate; and another parcel, in a small furnace, mixed with the charcoal used as fuel.

In these experiments, it was observed that the pieces of this mixture of quick lime and clay, which

were burnt on the heated plate, produced mortar that set under water; but those burnt mixed with charcoal, produced a mortar which did not set under water.

Mr. Clement, when he gave an account of a mineral found by Mr. Minard in France, and which was fit for the making of hydraulic mortar or Roman cement, stated it to be Mr. Minard's opinion, that the cause of the Roman cement setting under water, was owing to a subcarbonate of lime, produced by the action of fire on the natural carbonate, as the chemists speak, or in other words, to imperfect lime.

HINTS ON USING THE MICROSCOPE.

When we reflect on the series of observations which have been made with the microscope, we shall quickly be convinced that it is not from want of knowledge of the mathematical, physical, and chemical sciences, that the use of this instrument has given results so far from precise. A fatal idea, which took possession of men's minds even from the period of its invention, has unceasingly exerted its influence over the observations made with the microscope, in defiance of the observer's rectitude of judgment; and it has paralysed the ablest efforts, and deluged science with ridiculous systems or erroneously-stated facts. From the moment, in fact, that the combination of two or three lenses enabled men to contemplate things which were invisible to the naked eye, the disposition towards the marvellous led them to exclaim—"A new world is laid open before us!" and this world appeared to be regulated by new laws—every thing in it was interesting, but every thing was inexplicable; and the importance of the microscope was limited to its taking place of the phantasmagoria in public courses, and furnishing in the closet a relaxation from arduous researches. If a few authors did use it as an instrument of discovery, their method of investigation was confined to looking at objects and making lists of them—to drawing and giving explanations of figures; and, as no one could regulate their labours, so they did not perceive the necessity of doing it for themselves; they were believed, or at least quoted, on their simple word, and the best observer was he who drew the most numerous and the most pleasing figures. It is right, however, to say, that two or three observers conceived the idea of submitting the results obtained by the microscope to the rules of reasoning which direct us in our researches on the larger scale; and a certain degree of success crowned this idea; but they became presently tired and impatient at the new obstacles which they met with, and abjured their acquired knowledge and their judgment, plunging back into doubt for fear of falling into absurdity.

Now the range of our eyes does not influence the nature of bodies. The thing which I see by the help of a lens of feeble power appears to me evidently identical with what I see by the unassisted eye; if I shorten the focus of the lens, and, consequently, increase the magnifying power, I shall see much more, but shall I see differently? Will this stone, whose properties I can ascertain by the naked eye, acquire others diametrically opposite when I have divided it into microscopic fragments? No. Why then shall I not explain the appearances which its divided fragments exhibit, according to the same laws which explain so perfectly those presented by the entire block? If the microscope, instead of disclosing a new world, does nothing but bring within the reach of the eye particles too minute to be seen without it—if it only serves us to unravel mixtures of substances too much divided to be otherwise distinguished—if it enables us to penetrate further into the structure of organs, let us derive from this instrument a fruitful harvest of discoveries, by submitting the phenomena which it enables us to witness to all the reactions and tests which we make use of in our researches on the large scale; in short, let us not seek for the marvellous, nor for ingenious hypothesis, by its help, but for positive results.

The first rule, or rather the fundamental principle of this method is "*To inquire, in studying an organic body, into all the laws under whose influence it has been developed, and to which it is still subject.*"

In regard to the forms of bodies, we begin by observing with the naked eye those organs in which the microscopic bodies are formed; and we describe them, and delineate them with the most scrupulous exactness; and this cannot be attained without many repeated dissections and frequent failures. When these organs are soft and liable to lose their form, or to be confusedly huddled together, they must be dissected and observed under pure water or alcohol. For this purpose a vessel must be used whose sides are but slightly elevated, and having in its bottom a slice of cork on which the portions of the organs that it is wished to obtain separate must be fixed or stretched by pins, while the other parts are allowed to unravel themselves spontaneously as they float about in the liquid.

When we have finished the study of a body by the naked eye, those portions whose details the eye has been unable to perceive are submitted to the lens, in the same vessel. A lens slung like a watchmaker's glass is sufficient for this purpose. A reflector placed below illuminates the objects placed on it, and a watchmaker's glass serves to examine them. A glass vessel of very small depth may be substituted for the plate of glass.

The small parts observed by this lens and separated from the rest are transferred to the object-holder of the microscope, where their form is determined with the same precision. Here it is that illusions are multiplied in the old method, according to which observers were content to look at and make lists of objects. The play of light and shade is capable of presenting the most deceptious images; the object is, in short, so to speak, a body seen indistinctly from a distance.

Opaque objects are examined by placing them at some distance from the object-glass, and employing only the direct light of the sky. By means of two needles they are turned in every direction, and, if complicated in structure, they are even dissected; and they are delineated, when due allowance has been made for all the effects of the light falling on them and reflected by them.

Transparent objects ought to be viewed by transmission, under the power of a regulated intensity of light; and, in certain liquids, we must employ the less light the more transparent the objects are.

They are first observed dry; and, seeing that these bodies have different density from that of the surrounding air, and that the rays of light are the more refracted the greater the difference of density

of the media which they traverse, it follows that, in successively entering the substance of observation, and again passing out of it into the air, they will be strongly deflected from the perpendicular, and sent off to the right and left instead of reaching the focus of the microscope, which, therefore, will only receive those rays which directly traverse the vertical axis of the observed object. This is the reason why a grain of fecula, when examined dry, looks like a black ball having a luminous hole in its centre. The same effect takes place when, instead of observing a grain of fecula in the air, we look at a bubble of air in a medium approaching in density to that of fecula, as, for example, in water. The small spherical bulla exhibits concentric circles, some more opaque than others, and a luminous point in the centre; and, when several of these bullæ adhere together, then all their points of contact are rendered luminous by the new refraction which the rays that formerly were lost on the right and left of the focus are now made to undergo.

Consequently, the difference of density between a body and the medium in which it is placed, may be distinguished with the microscope, by the action which it exerts on the rays of light. If, for example, a grain of fecula be placed in air, the blackness of its border shows that its substance possesses a refractive power, and consequently, a considerably greater density than the surrounding air; but the same grain, plunged into water, becomes so transparent that it becomes necessary to employ a diaphraghm, in order to diminish the intensity of the light, that its outlines may become discernable. These outlines will be more shaded, if we dissolve in the water any salt which increases its density. Hence, the density of the substance inclosed in the membrane of the grain of fecula differs but little from that of pure water. The same rule is applicable to two liquids examined while they are yet but imperfectly mixed together. We shall judge that they differ in density, when we see striæ of a syrupy appearance meandering through the mass, and gradually disappearing as the mixture or the combination becomes more intimate. It is by the same means that we establish the identity of the refractive power, and consequently of the density, of pure woody matter and dried gum—by allowing the fibres of cotton to dry on the object-holder in a solution of gum arabic; when quite dry, the whole appears homogeneous.

(To be continued.)

MISCELLANIES.

Photography.—M. Daguerre's drawings are considered to want light and vigour, being dull and overcast; those presented by Mr. Fizeau to the French Academy are of a ravishing firmness and neatness, with stronger shades and light than any yet produced. Evidently in this case, photography seems to cast off the veil which shaded her so mournfully, to appear worthy of the light that creates her. Besides those eminent qualities above mentioned, let us add some not less estimable; such as being less shining, glaring and unalterable —since they can be preserved between two sheets of paper, and a glove passed over without causing them any damage. The hypo-sulphate of gold and soda, which produces these wonders, is thus composed—20 grains of chloride of gold, and 60 grains of hypo-sulphate of soda, are dissolved each in a pint of distilled water. The iodated-metallic plate, after being washed with the greatest care, with a sufficient quantity of the above solution, is placed on an iron frame over a lighted lamp—one or two minutes are sufficient for producing the effect desired. The author explains this happy result thus:—the gold, it appears, precipitates on the silver, it makes it darker, and gives so much more vigour to the shades, while they are less shining on the other part, and in its arrangement with the globules of mercury form the lights, and gives them more fixity and brightness.—*Taunton Courier.*

To Imitate Ground Glass for receiving an Impression.—Take one pound of ground rice, and two quarts of soft water, boil it until it is of the consistence of cream, then strain it through muslin, and add to it twenty-four drops of spirits of turpentine, and lay it on one side of the glass, with a sponge—then take a print, and dip it into vitriolic acid, and lay it smoothly on the coated side of the glass, and place it into an oven of moderate heat, and the landscape will be left on the glass in a very secure manner, and will bear washing with any acid.

Method of taking the Impression of Butterflies on Paper.—Clip the wings off the butterfly, lay them on clean, in the form of a butterfly when flying. Spread some thick clean gum-water on another piece of paper, press it on the wings, and it will take them up; lay a piece of white paper over it, and rub it gently with the finger, or the smooth handle of a knife. The bodies are to be drawn in the space left between the wings.

Buttons.—The manufacture of buttons has at length reached the *ne plus ultra* of perfection An ingenious Frenchman has invented a button, in which the principal of nut and screw is applied, so that without a stitch, buttons may be far more securely as well as more speedily, put upon clothes than in the ordinary way; and those who have no souls above buttons, may, if they please, have half a dozen suits of buttons to each suit of clothes, the top being screwed on to the shank. Mr. John Bell has obtained the first use of the patent, and if the Birmingham manufactures can produce the new article at a moderate price, the old button will probably become obsolete.—*Taunton Courier.*

[Another advantage in buttons made in the above manner is, that they could be easily taken from the fronts of shirts, waistcoats, trousers, &c., previous to sending the same to be washed or mangled—the common buttons being so frequently broken in those operations.—G. C.] We have inserted the above at the request of a Correspondent, but have little faith in the perfection of them, as the screw upon which the shank fits is sewed on to the cloth as the whole button is at present.

Blue Writing Ink.—A good and cheap blue ink may be made of the following ingredients:—

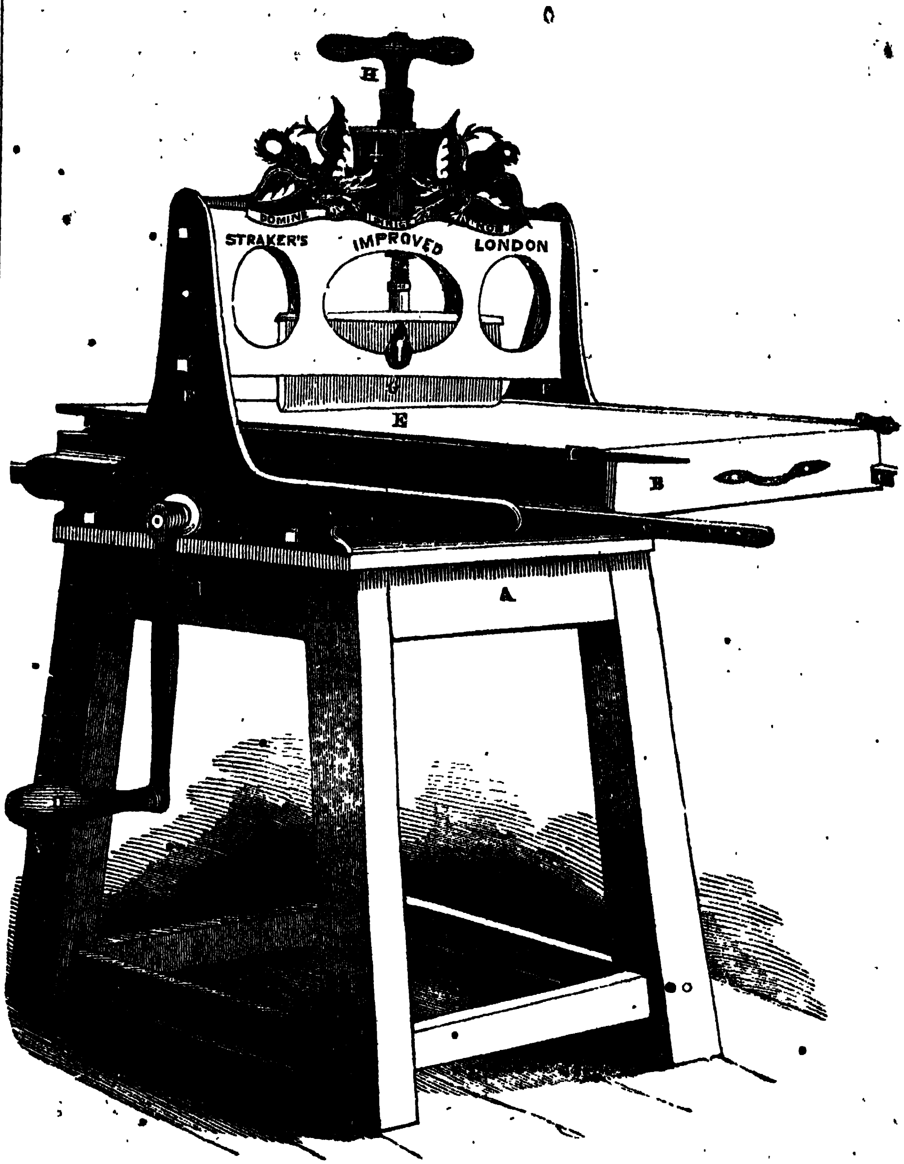
Prussian blue	2 drachms.
Oxalic acid	4 do.
Water	1 pint.

G. C.

ERRATA.

In page 136, for "hydrochlorate" of potass, read "hydriodate" of potass.

Page 164, 1st column, for stamens "1 short," read "2 short," and in the 2nd column, for stamens "4 short," read "2 short."



LITHOGRAPHY.

LITHOGRAPHY.

(Continued from page 176.)

We have given, in No. 69, figures and descriptions of various articles necessary in lithographic processes, and among others of one of the earlier and most simple lithographic presses; taking, at the same time, the opportunity of observing, that it was not adapted for large work, although its inconvenience in size will be apparent. Since that time, we have taken much trouble in inspecting the more modern presses, and are happy this week to introduce to the notice of our readers, one contrived, and which has been long used with the most perfect success, in the lithographic establishment of its inventor, Mr. Straker, of Bishopsgate Street. It is portable, occupies but little space, is easy to use, of great power, and turns out the work in the best manner.

Its general structure will be easily understood by the Fig. A is a strong wooden frame or table, B is the platten or bed of the press. It is perfectly flat, and runs upon rollers on the two rails C C, the same as the bed of a common printing press. This is the part upon which the stone is placed. B is furnished with an upright ledge at one end, about as high as the stone usually is; upon the top of this ledge are two hinges, upon which the tympan E is fixed in the usual manner. Of course, when the press is drawn out, these parts turn back, and leave the stone exposed. In the cut they are represented as closed down upon the stone. D is the handle which moves the bed backwards and forwards. F F are the two iron sides which support the scraper G. G is formed of box-wood, cut with a levelled edge below as represented, and fastened at the top to the lower end of the screw H. The manner of using the press scarcely needs description. The bed is drawn out, the tympan thrown back, the stone inked, and the paper placed upon it; the tympan is then shut over the paper. The screw H is turned or forced down, which brings the scraper close down upon the stone, near where the end of the paper is; the handle is then turned, which drags the bed forwards, owing to a small wheel and rack within side, the handle H is now loosened, the bed moves easily back, and the paper now printed may be removed, and the operation repeated.

The above figure and description represents a press 20 inches by 26, but they are made of all sizes and prices, as the following table will exhibit, and which we give the more readily, as very numerous country Correspondents have requested from us the information.

Size.				£.	s.	d.
Press, 9 inches by	14 inches, costs..			5	5	0
" 15	"	20	" ..	7	10	0
" 18	"	23	" ..	9	10	0
" 20	"	26	" ..	12	12	0
" 24	"	30	" ..	17	0	0
" 26	"	34	" ..	20	0	0
" 28	"	40	" ..	22	10	0
" 30	"	45	" ..	25	0	0
" 32	"	55	" ..	28	10	0
Press Stands....................				0	12	0

Preparation of the Stone for Printing.—The drawing being finished on the stone, it is sent to the lithographic printer, on whose knowledge of his art depends the success of the impressions. The first process is to *etch* the drawing as it is called. This is done by placing the stone obliquely on one edge, over a trough, and pouring over it very dilute nitric acid. It is poured on the upper part of the stone, and runs down all over the surface. The stone is then turned, and placed on the opposite edge, and the etching water being collected from the trough, is again poured over it, in the same manner. The degree of strength, which is usually about one per cent. of acid, should be such as to produce a very slight effervescence; and it is desirable to pass the etching water two or three times over the darkest parts of the drawing, as they require more etching than the lighter tints. Experience alone can, however, guide the lithographer in this department of the art, as different stones, and different compositions of chalk, will be differently acted upon by the acid; and chalk drawings require a weaker acid than the ink. The stone is next to be carefully washed, by pouring clean rain water over it, and afterwards gum water; and when not too wet, the roller charged with printing ink is rolled over it in both directions—sideways, and from top to bottom—till the drawing takes the ink. It is then well covered over with a solution of gum Arabic in water, of about the consistency of oil. This is allowed to dry, and preserves the drawing from any alteration, as the lines cannot spread, in consequence of the pores of the stone being filled with the gum. After the etching, it is *desirable* to leave the stone for a day, and not more than a week, before it is printed from. The effect of the etching is first to take away the alkali mixed with the chalk or ink, which would make the drawing liable to be affected by the water; and, secondly, to make the stone refuse more decidedly to take any grease. The gum assists in this latter purpose, and is quite essential to the perfect preparation of the surface of the stone.

Printing.—When the intention is to print from the stone, it is placed upon the platten or bed of the press, and a proper sized scraper is adjusted to the surface of the stone. Rain water is then sprinkled over the gum on the stone, which, being dissolved gradually, and a wet sponge passed lightly over all, the printer works the ink, which is on the color table placed beside him, with the roller, in all directions, until it is equally and thinly spread on the roller. The roller is then passed over the whole stone, care being taken that the whole drawing receives a due portion of ink; and this must be done, by giving the roller an equal motion and pressure, which will of course require to be increased, if the drawing does not receive the ink readily. When the drawing is first used, it will not receive the ink so readily as it will afterwards; and it is frequently necessary to wet the stone, and roll it several times, before it will take the ink easily. After this takes place, care must be taken not to wet the stone too much; the dampness should not be more than is necessary to prevent the ink adhering to the stone where there is no drawing. After the drawing is thus rolled on, the sheet of paper is placed on the stone, and the impression taken. Upon taking the paper off the stone, the latter appears to be quite dry, owing to the paper having absorbed the moisture on the surface; it must therefore be wetted with a sponge, and again rolled with ink, the roller having been well worked on the color table before being applied. During the printing, some gum must always remain on the stone, although it will not be visible, otherwise the ink will be received on the stone as well as on the drawing, by which the latter would be spoiled; so that if by too much wetting, or by rubbing too hard with the sponge,

the gum is entirely removed, some fresh gum water must be laid on. If the stone has, in the first instance, been laid by with too small a quantity of gum, and the ink stains the stone on being first applied to it, gum water must be used to damp the stone, instead of pure water. Sometimes, however, this may arise from the printing ink being too thin, as will afterwards appear. If some spots on the stone take the printing ink, notwithstanding the above precautions, some strong acid must be applied to them with a brush, and after this is washed off, a little gum water is dropped in the place. A steel point is here frequently necessary to take off the spots of ink. The edges of the stone are very apt to get soiled, and generally require to be washed with an old sponge after rolling in; they must also frequently have an application of acid and gum, and sometimes must be rubbed with pumice-stone. If an ink is too thin, and formed of a varnish not sufficiently burned, it will soil the stone, notwithstanding the proper precautions are taken of wetting the stone, and preparing it properly with acid and gum; and if, on the other hand, the ink is too thick, it will tear the lighter tints of the chalk from the stone, and thus destroy the drawing. The consideration of these circumstances leads at once to the—

Principles of the Printing.—The accidents just mentioned arise at the extreme points of the scale at which the printing inks can be used, for it is evident that the only inks that can be used are those which are between these points; that is, thicker than that which soils the stone, and, at the same time, thinner than that which takes up the drawing. Lithographers are sometimes unable to print in very hot weather, the reason of which may be deduced from the foregoing. Any increase of temperature will diminish the consistency of the printing ink; the stone will therefore soil with an ink which could be safely used at a lower temperature: hence a stiffer ink must be used. Now, if the temperature should increase so much that the stone will soil with any ink at all less thick than that which will take up the drawing, it is evident that the printing must cease till a cooler temperature can be obtained; for as the drawing chalk is affected equally with the printing ink, the same ink will tear up the drawing at the different degrees of temperature. This, though it sometimes occurs, is a rare case; but it shows that it is desirable to draw with a chalk or ink of less fatness in summer than in winter; and also, that if the printing room is in winter artificially heated, pains should be taken to regulate the heat as equally as possible.

Other Difficulties in Printing, not referable to the foregoing general Principle.—If the pressure of the scraper be too weak, the ink will not be given off to the paper in the impression, although the drawing has been properly charged with it. Defects will also appear from the scraper being notched, or not correctly adjusted, or from any unevenness in the leather or paper. After printing a considerable number of impressions, it sometimes happens that the drawing takes the ink in dark spots in different parts. This arises from the printing ink becoming too strongly united with the chalk or ink of the drawing, and if the printing be continued, the drawing will be spoiled. The reason of this is easily ascertained. The printing ink readily unites with the drawing, and being of a thinner consistency, it will, by repeated applications, accumulate on the lines of the drawing, soften them, and make them spread. In this case, it is necessary to stop the printing, and let the stone rest for a day or two, for the drawing to recover its proper degree of hardness. If the drawing should run smutty from any of the causes before enumerated, the following—

Mixture for Cleaning the Drawing while Printing must be used.—Take equal parts of water, spirits of turpentine, and oil of olives, and shake them well together in a glass phial, until the mixture froths; wet the stone, and throw this froth upon it, and rub it gently with a soft sponge. The printing ink will be dissolved, and the whole drawing will also disappear, though, on a close examination, it can be distinguished in faint white lines. On rolling it again with printing ink, the drawing will gradually re-appear, as clear as at first.

Bleached Paper unfit for Lithographic Printing.—Accidents sometimes occur in the printing from the qualities of the paper. If the paper have been made from rags which have been bleached with oxymuriatic acid, the drawing will be incurably spoiled after thirty impressions. Chinese paper has sometimes a strong taste of alum; this is so fatal, as sometimes to spoil the drawing after the first impression. When the stone is to be laid by after printing, in order that it may be used again at a future period, the drawing should be rolled in with a—

Preserving Ink; as the printing inks would, when dry, become so hard, that the drawings would not take fresh printing ink freely. The following is the composition of the preserving ink:—Two parts of thick varnish of linseed oil, four parts of tallow, one part of Venetian turpentine, and one part of wax. These must be melted together, then four parts of lamp black, very carefully and gradually mixed with it, and it must be preserved for use in a close tin box.

AGENCY OF MAN IN THE DISTRIBUTION OF PLANTS.

"When the introduction of cultivated plants," says De Candolle, "is of recent date, there is no difficulty in tracing their origin; but when it is of high antiquity, we are often ignorant of the true country of the plants on which we feed. No one contests the American origin of the maize or potato; nor the origin, in the Old World, of the coffee-tree, and of wheat. But there are certain objects of culture, of very ancient date, between the tropics, such, for example, as the banana, of which the origin cannot be verified. Armies, in modern times, have been known to carry, in all directions, grain and cultivated vegetables from one extremity of Europe to the other; and thus have shown us how, in more ancient times, the conquests of Alexander, the distant expeditions of the Romans, and afterwards the Crusades, may have transported many plants from one part of the world to the other."

But, besides the plants used in agriculture, the number which have been naturalized by accident, or which man has spread unintentionally, is considerable. One of our old authors, Josselyn, gives a catalogue of such plants as had, in his time, sprung up in the colony since the English planted and kept cattle in New England. They were two-and-twenty in number. The common nettle was the first which the settlers noticed; and the plantain was called by

the Indians "Englishman's foot," as if it sprung from their footsteps.

"We have introduced every where," observes De Candolle, "some weeds which grow among our various kind of wheat, and which have been received, perhaps, originally from Asia along with them. Thus, together with the Barbary wheat, the inhabitants of the south of Europe have sown, for many ages, the plants of Algiers and Tunis. With the wools and cottons of the East, or of Barbary, there are often brought into France the grains of exotic plants, some of which naturalize themselves. There is, at the gate of Montpellier, a meadow set apart for drying foreign wool after it has been washed. There hardly passes a year without foreign plants being found neutralized in this drying-ground. I have gathered there Centaurea parviflora, Psoralea palæstina, and Hypericum crispum." This fact is not only illustrative of the aid which man lends inadvertently to the propagation of plants, but it also demonstrates the multiplicity of seeds which are borne about in the woolly and hairy coats of wild animals.

The same botanist mentions instances of plants naturalized in sea-ports by the ballast of ships; and several examples of others which have spread through Europe from botanical gardens, so as to have become more common than many indigenous species.

It is scarcely a century, says Linnæus, since the Canadian erigeron, or flea-bane, was brought from America to the botanical garden at Paris: and already the seeds have been carried by the winds, so that it is diffused over France, the British islands, Italy, Sicily, Holland, and Germany. Several others are mentioned by the Swedish naturalist, as having been dispersed by similar means. The common thorn-apple, observes Willdenow, now grows as a noxious weed throughout all Europe, with the exception of Sweden, Lapland, and Russia. It came from the East Indies and Abyssinia to us, and was so universally spread by certain quacks, who used its seed as an emetic.

In hot and ill-cultivated countries, such naturalizations take place more easily. Thus the Chenopodium ambrosiodes, sown by Mr. Burchell on a point of St. Helena, multiplied so in four years as to become one of the commonest weeds in the island.

The most remarkable proof, says De Candolle, of the extent to which man is unconsciously the instrument of dispersing and naturalizing species, is found in the fact, that in New Holland, America, and the Cape of Good Hope, the aboriginal European species exceed in number all the others which have come from any distant regions; so that, in this instance, the influence of man has surpassed that of all the other causes which tend to disseminate plants to remote districts.

Although we are but slightly acquainted, as yet, with the extent of our instrumentality in naturalizing species, yet the facts ascertained afford no small reason to suspect, that the number which we introduce unintentionally exceeds all those transported by design. Nor is it unnatural to suppose that the functions, which the inferior beings, extirpated by man, once discharged in the econom of nature, should devolve upon the human race. If we drive many birds of passage from different countries, we are probably required to fulfil their office of carrying seeds, eggs of fish, insects, mollusks, and other creatures, to distant regions; if we destroy quadrupeds, we must replace them, not merely as consumers of the animal and vegetable substances which they devoured, but as disseminators of plants, and of the inferior classes of the animal kingdom. We do not mean to insinuate that the very same changes which man brings about would have taken place by means of the agency of other species, but merely that he supersedes a certain number of agents; and so far as he disperses plants unintentionally, or against his will, his intervention is strictly analogous to that of the species so extirpated.

We may observe, moreover, that if, at former periods, the animals inhabiting any given district have been partially altered by the extinction of some species, and the introduction of others, whether by new creations or by immigration, a change must have taken place in regard to the particular plants conveyed about with them to foreign countries. As, for example, when one set of migatory birds is substituted for another, the countries from and to which seeds are transported are immediately changed. Vicissitudes, therefore, analogous to those which man has occasioned, may have previously attended the springing up of new relations between species in the vegetable and animal worlds.

It may also be remarked, that if man is the most active agent in enlarging, so also is he in circumscribing, the geographical boundaries of particular plants. He promotes the migration of some, he retards that of other species, so that, while in many respects he appears to be exerting his power to blend and confound the various provinces of indigenous species, he is, in other ways, instrumental in obstructing the fusion into one group of the inhabitants of contiguous provinces.

Thus, for example, when two botanical regions exist in the same great continent, such as the European region, comprehending the central parts of Europe and those surrounding the Mediterranean, and the Oriental region, as it has been termed, embracing the countries adjoining the Black Sea and Caspian, the interposition between these of thousands of square miles of cultivated lands, oppose a new and powerful barrier against the mutual interchange of indigenous plants. Botanists are well aware that garden plants naturalize and diffuse themselves with great facility in comparatively unreclaimed countries, but spread themselves slowly and with difficulty in districts highly cultivated. There are many obvious causes for this difference: by drainage and culture the natural variety of stations is diminished, and those stray individuals by which the passage of a species from one fit station to another is effected, are no sooner detected by the agriculturist, than they are uprooted as weeds. The larger shrubs and trees, in particular, can scarcely ever escape observation, when they have attained a certain size, and will rarely fail to be cut down if unprofitable.

The same observations are applicable to the interchange of the insects, birds, and quadrupeds of two regions situated like those above alluded to. No beasts of prey are permitted to make their way across the intervening arable tracts. Many birds, and hundreds of insects, which would have found some palatable food amongst the various herbs and trees of the primeval wilderness, are unable to subsist on the olive, the vine, the wheat, and a few trees and grasses favored by man. In addition, therefore, to his direct intervention, man, in this case, operates indirectly to impede the dis-

semination of plants, by intercepting the migrations of animals, many of which would otherwise have been active in transporting seeds from one province to another.

Whether, in the vegetable kingdom, the influence of man will tend, after a considarable lapse of ages, to render the geographical range of *species of genera* more extended, as De Candolle seems to anticipate, or whether the compensating agency above alluded to will not counterbalance the exceptions caused by our naturalizations, admits at least of some doubt. In the attempt to form an estimate on this subject, we must be careful not to underrate, or almost overlook, as some appear to have done, the influence of man in checking the diffusion of plants, and restricting their distribution to narrower limits.

BOOKBINDING

(Resumed from page 195.)

Having thus briefly noticed some of the machinery which is employed by the bookbinder, we return to the book, the edges of which had just been cut; the next thing, therefore, is to ornament its edges, which is done either by coloring, sprinkling, marbling, or gilding. The first of these processes is the most simple, and is that usually adopted for the commonest work. The books being laid one on the other, or screwed in the cutting-press, the color is applied with a sponge. The colors mostly employed for this purpose, are Spirit-blue, Brown-umber, King's-yellow, Dutch-pink, Spanish-brown, and Vermilion, mixed with size. Sprinkling is performed by dipping a stiff brush in the color, and striking it upon the press-pin held in the left hand, by which means the color is thrown upon the books in fine spots, and a little practice enables the workman to distribute them very equally all over the edges. Better kinds of books, however, are generally marbled on the edges, the patterns being made to correspond with the marble paper lining. Marbling is performed as follows:—a trough is provided of a convenient size, about two inches deep, which is filled with clean gum-water; various colored pigments, ground in spirits of wine, and mixed with a small quantity of ox-gall, are then thrown upon the surface of the gum-water, and disposed in various forms, according to the pattern that is desired, with a quill and comb. The proper pattern being obtained, the book is tied between two boards, and the edges dipped into the trough, when the floating colors become transferred to the book; cold water is immediately dashed over the edges, which sets the colors, and gives them a clear appearance. If the edges are to be gilt, they are nicely cut and tied between two boards; they are then sponged over with yellow-ochre, which is scraped off, and the edges rubbed dry with paper shavings. Parchment size, or a size composed of equal parts of water and white of eggs, is laid upon the book edge, and covered with gold leaf; it is then dried gradually, and before it gets quite hard, is burnished with an agate burnisher. The edges are then protected from injury during the remainder of the process by a paper covering. Head-banding then follows. Head-bands are of two kinds, *stuck on* and *worked*. The stuck-on head-band is formed by cutting a piece of striped or colored linen about an inch deep, and equal in length to the thickness of the book; one side is pasted, and a piece of well-twisted cord laid across one-third of its width; it is then folded over, inclosing the string, and worked well up to it. The back of the book being glued, the linen is laid upon it, the cord or head-band being placed flat upon the end of the leaves. For all extra work, however, the head-bands are worked in the following manner:—A strip of thick vellum, board, or string, prepared by rolling it tight in pasted paper, is taken of a dimension suited to the size of the book; stout well-twisted silk, of two or more colors, is then taken; if two colors are used, they are doubled and tied together by the ends, one of them being previously equipped with a needle. The book is then placed in the cutting-press with the back uppermost, the head towards the workman, and considerably elevated; the needle is then passed through the middle of the second section, on the left-hand side, just below the catch-stitch, and drawn out far enough to bring the knot joining the two silks close into the middle of the section; the needle is then brought up, and passed again through the same place, and the silk drawn nearly close; the round strip is placed in the loop thus formed, and the silk drawn tight with the left hand; the other silk is brought over with the right, and passed under and over the head-band, when that is held tight with the left hand; the other silk is now put over that, and also under and over the head-band; they are thus worked alternately over each other, as far as the middle section of the book, through which the needle is passed below the catch-stitch, and brought over the head-band, when the working is proceeded with as before, as far as the last section but one; the needle is passed through this section, and over the head-band twice, and finally fastened on the back. The ends of the head-band are then cut off, almost close to the silk at each end. The part produced by working one silk over the other is called the braiding, which forms the principal beauty of the head-band, and should be ranged close down upon the leaves of the book on the inside of the band, which is easily managed. Both ends of the book having been worked in this way, the glue brush is drawn across the back of the bands, which strengthens them, and keeps them in their proper places. It is now the usual practice to make a hollow back, on account of its enabling the book to open better, and also preserving the leather from cracking. The hollow back is formed by cutting a strip of cartridge paper twice the width of the back, and the same length; this is folded in half, and the back being fresh glued, one half of the folded paper is stuck on, the other half being doubled upon it. If the book is to have raised bands, they are now put on; they are formed of strips of thick leather, as wide, and at such distances from each other, as taste directs; they are glued on the loose back, and pared down at the ends, the sides being kept sharp and square. They are used to give a neat appearance to the back, and are a great improvement on the old method of sewing the book on raised bands in lieu of the sunken cords. The book is then ready for covering, with leather, if to be whole bound, or with leather and paper, if to be only half-bound. For whole binding the leather is cut about half an inch larger all round than the book, and carefully pared round the edge with a sharp knife on a piece of smooth marble; it is then pasted, folded together, and left a few minutes for the paste to soak in; it is then opened out, and the book laid on one half (the fore-edge being towards the work-

man), while the other half is carefully and tightly drawn over the back and uppermost cover; the covers being then adjusted at the head and foot, and pulled forward, the edges are turned down and the ends tucked in; the corners being raised are worked together, and the part so raised cut off, and the head and foot pieces being smoothed down, the fore-edge part is folded over them. The head of the book is then neatly set with the folding-stick, pressing it inwards in the joint where the corner was taken off the boards, and flatting the leather over the top of the head-bands; the form thus given in the damp state is permanently retained when dry. If the raised bands, previously described, are used, a piece of fine cord is tied round the book, (the edges being guarded with a piece of board), pressing on the upper and lower side of each band, which brings the cover close upon the back, and preserves the distinctness of the bands. For half-bound books a strip of leather is cut, about an inch longer than the back of the book, and of sufficient width to lay well over the boards; the leather corner pieces are cut of an oblong quadrangular shape. The leather being pared, the corner pieces are put on first, and the back afterwards, being worked in the same manner, and with the same care, as the whole-bound book. Marble, colored, or other fancy paper, is cut of a proper size and form, and pasted on the sides. Smooth sheep and calf bindings are frequently ornamented by marbling or sprinkling, which is performed by throwing various coloring liquids on the cover while it is wet with water: but there is so great a variety in these processes, both of colors and patterns, that there is not space for their enumeration here; nor are they of much importance at this time, the colored leathers having been brought to such perfection, and in so general use, as to render the employment of sprinkling, &c. of more rare occurrence than formerly. The *forwarding* of the book is now completed, and it is handed over to the finisher.

The first step of the finisher is to wash the cover of the book with paste or glue water, to prevent the glaire from sinking in and staining the cover; when the sizing is dry the cover is glaired. Morocco and roan require to be glaired but once, sheep twice, and calf three times; this done, the book is ready for gilding and lettering. The places where the gilding is to be applied, are then slightly greased with palm or sweet oil, and covered with gold leaf. While lettering and gilding the back, the book is placed in the cutting-press, with the head a little elevated. The brass letters having been selected and laid in their proper order before a fire, are moderately heated; before using they are tried on a piece of waste leather; when at the proper temperature, they are forcibly impressed upon the gold, one after the other, care being taken to keep them straight, upright, and at uniform distances—a process which requires great practical skill. The whole of the letters being worked, the superfluous gold is wiped off with an oiled rag, to which it adheres, and when saturated, the rag is sold to the refiner, who recovers the gold which it contains. Common words of frequent use, such as *Bible, Prayer, Album,* &c. are cut in one piece, and worked off at once, which greatly facilitates the process of lettering, while it insures a uniformity of appearance not otherwise attainable.

The lettering having been completed, the remainder of the book is gilt with appropriate tools; these in general consist of straight lines or fillets, rolls of various breadths and patterns, and single ornamental devices, all cut in brass, and used the same way as the letters. The tools are frequently heated, and worked upon the leather without the interposition of gold, which produces a neat and elegant contrast to the gilding: it is denominated *blind-tooling.* Whole bound books are frequently very handsomely gilt on the sides as well as the back, frequently by running a broad gold roll round the edges of the cover, and sometimes by means of corner and centre pieces, with or without lines.

When very large lettering pieces, ornaments, or coats of arms, &c., are to be gilt upon the covers of books, manual pressure is inadequate to the working of them, and a press is employed, called an arming press. A very perfect machine of this description has recently been constructed by Messrs. Cope and Sherwin, of London, to which they have given the name of the "Imperial Arming and Embossing Press," which is not only capable of working every description of gilding, but is also sufficiently powerful to emboss the elegant arabesque covers, at present so much employed for ornamental bookbinding. The largest description of these covers are embossed by means of a fly-press of enormous power, but for all smaller work the imperial press is amply sufficient. In its construction it resembles the improved printing press invented by the same parties, but with the addition of a contrivance for raising or lowering the bed to suit the thickness of the book, and the platten likewise having receptacles for the heating irons. By means of a screw-and-wedge adjustment in the piston, and the rising and falling bed-plate, a considerable range, with the power of very accurate adjustment, is obtained with great facility. The machine is exceedingly simple in principle and construction, elegant in appearance, and effective in operation, and is a valuable auxiliary to the book-binder. The book having been gilded, it is polished with a hot iron, and the edges, if coloured or marbled, are burnished with an agate burnisher: the book is then finished. If the book was only intended to be put in boards, or, as it is technically called, *boarded,* it is folded, sewed, glued, the covers cut to the size and put on, and then covered with colored paper, the edges of the book remaining uncut. *Extra boarding* has stouter boards than the former, and is finished with rather more care; sometimes the edges are cut, and the book covered with a neat colored and embossed or printed cloth, which gives a very neat appearance at a cheap rate.

(Vellum binding as early as possible.)

PROCEEDINGS OF THE BRITISH ASSOCIATION AT GLASGOW.

THE meetings of this body commenced, as our readers are aware, on Thursday, Sept. 17th. The arrival of strangers and distinguished foreigners was very great for some days previously, more so indeed than it is supposed at any preceding meeting of the Association. The preparations in the different sectional departments were on Wednesday brought to a conclusion, and every thing appears to go on smoothly. It is the proceedings at these sections which are alone interesting to our readers. Leaving, therefore, unnoticed the details of mere business, we shall proceed to give an abstract of what has been done in the way of science. First observing, that the various museums of mechanical inventions, articles of taste and elegance, objects of geology,

and others of natural history, were thrown open to all the members at various parts of the town. Some of these mechanical contrivances we shall endeavour to obtain a description of. The following communicator, invented by Mr. Prutin, for giving signals when a galvanic telegraph is to work, that is to ring a bell at a distant station, obtained general attention and applause.

Mr. Prutin's Galvanic Communicator consists of two coils of copper ribbon attached together, and placed parallel to each other, with a space between them. Two needles are suspended within the coils, having a platinum wire terminating in a small spiral coil across the direction of the needle. Under the end of the platinum wire is placed a spirit lamp, with a small flame, by means of which the platinum coil is maintained at a white heat. When the needle deviates by means of the galvanic influence transmitted from the other end of the telegraph, it carries round with it the hot platinum coil, which meets with a fine cotton thread stretched in its course. This thread is attached to a cord, by which a pendulum is drawn aside from a bell or gong, upon which it tends to fall. The moment that the hot wire touches the thread, it burns it, and the pendulum, being freed, strikes the bell, or gong, and thus the attention of the person at the telegraph is called to the signal that is made.

Next to the above, the object which most arrested the notice of the meeting was the *Alpaca,* an animal of the Lama tribe, native of the Cordilleras, or mountain district of Peru, very valuable for its wool, importations of which have already taken place to the extent of 3,000,000 lbs. It is used as deer in the parks of the Spanish grandees in Peru, and its flesh is equal to any venison. Some are white, others brown and mottled. The Alpaca does not perspire as sheep do, and therefore requires no smearing, which will be an immense saving to the Scotch farmer; and the heavy coat of wool on its body, (fine as silk,) is sufficient protection in the Peruvian mountains, where deluges of rain fall four months in the summer season; and from the Alpaca living under the line of perpetual snow, it proves that a cold climate is congenial to them even in winter. The Alpaca lives on "zeho," a kind of withered grass which grows on all mountains above a certain altitude—proving that they will exist where sheep will not. Specimens of different kinds of manufacture from Alpaca, in imitation of silk, were exhibited,—some black as jet, (without dye,) others white, colored, dyed, and wove in great variety of figures; can be manufactured at one-third the price of silk, and three times more valuable than Scotch wool. The Alpaca is especially adapted for Scotland, as recommended at the ninth meeting of the British Association. From Wm. Danson, Esq., Liverpool, samples of the raw Alpaca silky wool, assorted black, (without dye,) white, red, brown, foxy, grey, mottled, &c., are also to be seen. There is no animal grease in this wool — illustrative that the animal requires no washing before shearing. This Alpaca wool can at present be sold at 20*d.* per lb. During the panic of 1837, when Highland wool sold at 3½*d.* per lb., upwards of 1,000,000 lbs. of Alpaca realized 2*s.* and 2*s.* 6*d.* per lb.

Section A.—Mathematics and Physics.

The first paper was one by Professor Powell, which, in his absence, was read by Professor Whewell—On Latent Heat and the Refrangibility of Heat and Light.—Professor W. stated that the report was exceedingly voluminous, and he would; therefore, only read such portions of it as were likely to be most interesting. It was intended as a supplement to a former report on the same subject, and contained notices of the discoveries which had since been made in this branch of science, which had in a great measure altered the views previously entertained on the subject. The subject had now divided itself into two branches, unpolarised light and polarised heat. On these points the report detailed at great length the results of the various researches of Mr. Melloni and of Professor Forbes. Among other points which these researches had decided, was the fact, that the resistance on the transmission of heat was not in the surface, but in the body of the mass; that rock salt transmitted heat more freely than most other substances, so that 92 rays of heat passed through it, whether the heat arose from flame, red hot iron, or water at 212°. The report then alluded to the series of experiments on the transmission and refraction of heat, published by Professor Forbes in 1835. Among other experiments, he tried whether heat could be detected in the moon's rays, but he found no indication of its existence. If there did exist any, it be less than the 300,000th part of a degree in the centigrade thermometer, as tried by the thermo-multiplier. Professor Whewell stated that he would pass over a considerable portion of the report, which treated of the influence of color in the transmission of heat, and on the subject of the transmission of ice under water; and would give a few extracts relative to the experiments on the polarisation of heat. Mr. Melloni had tried experiments with tourmaline, but without effect. In 1834, however, Professor Forbes took up the subject, and succeeded in polarising the heat by means of plates of mica; and this formed the great point of the discovery. The next discovery was that of the Circular and Elliptical Polarisation of Heat, an account of which Professor Forbes had published in the Edinburgh Journal of Science, in March 1836. Among other points discovered, it was found that the quantity of rays transmitted was in proportion to the light used—thus with an argand, 74 out of 100 were transmitted, while with water there was only 44. Another important point was, that the wave of heat by the mica plates was three times the length of the wave of light. The report concluded by reviewing the progress of the discoveries, and allotting to the respective parties concerned in the discovery that share which each appeared to have in the elucidation of the subject.

In answer to a question by Professor Stevelley, Professor Forbes explained, by a diagram, the grounds on which he held the wave of heat to be so much longer than that of light. Professor Whewell made a few remarks on the same subject. Sir David Brewster, in the course of a few observations, referred to one or two important experiments. He stated, that if a solution of laurel leaves was made in alcohol, the result would be a green colored fluid. If this fluid be put into a bottle and looked down through, a red light would be seen, and no green; he also referred to certain effects produced by a film of Oil of Cassia between two plates of flint glass, and recommended a prosecution of the experiments.

The next report was one read by Professor Forbes on Meteorology, supplementary to a report read by him eight years ago. The report, he said, was so

long that he could only direct attention to one or two extracts. He had treated the subject under the different heads of Temperature in connection with the Barometer—Pressure in connection with the Barometer, and Meteorological observations generally—Atmospheric heat—The Temperature of the Sphere beyond the atmosphere—Solar radiation—Temperature of the globe itself—Humidity—Winds—Storms—Electricity—the November meteors—and concluded by a few suggestions on the subject of national and local observatories. The principal point on which he read extracts from his report was that of the temperature of the globe. He held that internal heat had little or no influence on the external crust of the earth, and that the portion of the sun's rays which reached through the atmosphere had little effect below the surface, except for a limited distance. The heat of the atmosphere decreased geometrically upwards as the heat of the globe increased arithmetically downwards. The heat sent down from the surface depended on the nature of the soil and its conducting power; and, except by thermometers placed at different depths, they could not arrive at a proper conclusion on the subject. The amount of solar heat lost by coming through the atmosphere he estimated at 25 per cent. on a vertical ray. The value of the specific heat of the soil was estimated at Paris at 56; but as to the same subject in this country, he would, during the meeting, give some results of experiments tried at Edinburgh. Within the tropics, the mean heat was found by putting the thermometer one foot below ground in the shade. Pouisson estimates the sun's influence at Paris at 24° centigrade; the mean temperature at Paris was 11° centigrade, leaving thus 13° centigrade, or 9° of Fahrenheit, as the temperature of the globe, were the sun entirely withdrawn, a temperature greater than that of the polar regions. He then alluded to the erroneous calculations of barometrical measurements, and instanced the case of the Caspian Sea, which barometrically was 300 feet lower than the Mediterranean, while, by actual levelling, it was only 80 feet. On the subject of Humidity he had given in his report some experiments on the dew point, and had suggested a new Theory of Winds; but he would not detain the Section by entering into these matters. He stated that on the August and November meteors the report gave an abstract of the papers which had appeared upon that subject. He concluded by reading some suggestions on the necessity of National Observatories, and the proper mode of managing them.

Professor Whewell next read a report on the subject of the Tides. The object was to ascertain the moon's mean declination; but as it varied every year, a number of years' observations would be required. From a series of observations made at Leith, a number of calculations had been made; and from observations also made at Liverpool, Bristol, and Portsmouth, tables had been made out to show the height of the tide at any hour of the day, according to the moon's age. Observations had also been made to determine the curve of the rise and fall of the tides, of which calculations had also been made. Diagrams of the curves were exhibited and explained to the Section.

After which, Mr. Smith, of Jordanhill, read part of a paper by Mr. Stevenson, on the changes of level of sea and land, which had taken place since or during the tertiary period. After giving a few extracts from the paper, Mr. S. described verbally the different beds of alluvial matter which overlay the regular strata in this neighbourhood. He stated, that there were beds of sand which he considered of a fluviatile formation; these overlay beds of gravel, which again repose on a bed containing many marine shells. These are found at different levels. He had found them at the height of 100 feet above the level of the sea; but others had got them much higher. He stated that about 15 per cent. of the shells were extinct or unknown, and many of the rest were common to the arctic seas, showing that the climate had altered from a colder to a warmer condition, since the formation of these deposits.

Dr. Scoullar having previously perused Mr. Stevenson's paper, gave a brief resume of its contents. It recommended the adoption of some means of making observations on the level of the tides, which should equally enable the fisherman, the peasant, and the philosopher in all parts of the world, to speak the same language on this subject, and unite in promoting the object they had in view.

M. De La Beche said he had been struck with the statement of Mr. Smith, that shells of the present day had been found in a particular formation at the height of forty feet. Was this, he asked, about the maximum? (Mr. Smith said it was nearly so.) It struck him, because in the progress of the present Ordnance Survey, forty feet was also the maximum of the elevation they had ascertained in Devonshire, Cornwall, &c. It was a remarkable coincidence, and would seem to show that a change in the level of the sea and land had taken place over a large area, and afforded evidence both of elevation and depression.

After some remarks by Mr. David Milne, and Dr. Buckland, the conversation terminated.

A short paper from Captain Baddely on the Geology of Canada was read, which gave rise to a conversation on the importance of Government appointing surveys of our North American colonies. It was observed that this was the more important, as there was a possibility that in the settlement of our differences with the United States, tracts of country might be exchanged, and, as Dr. Buckland remarked, we might be giving away a coal-field worth £10,000 or £20,000 an acre, for fields of granite not worth five shillings. A member bore the strongest evidence to the rich mineral resources of Nova Scotia and New Brunswick.

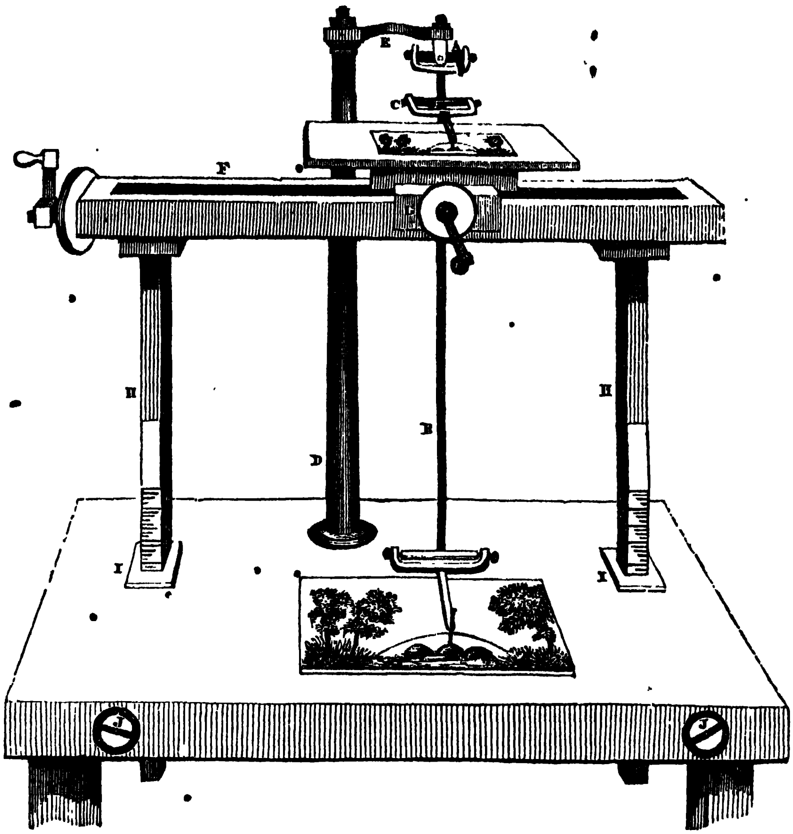
Mr. Bowman having read a paper on the Silurian rocks of Llangollen, illustrated by sections of the upper Silurian rocks between the valley of the Dee, from Mool Ferna to the Egcuyseg, and of the Silurian and associated igneous rocks between the river Tanat and the Denbighshire coal-field, the Section adjourned.

(Continued in our next.)

To the Editor.

SIR.—*Blow-pipe Jet.*—It is well known that the mixed gases, oxygen and hydrogen, will not explode when passing through a very narrow bore of a tube: how is it then that it never occurred to any of the inventors of the compound blow-pipe, that the minute perforations extending through a piece of cane may be used for a compound blow-pipe for the gases without fear of explosion? I have not been able to test its efficiency, perhaps some of your readers may be induced to do so. J.

Fig. 1.



MACLAURIN'S MACHINE FOR STUMP ENGRAVING.

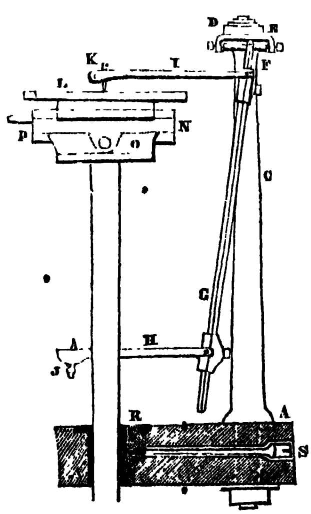


Fig. 2.

MACLAURIN'S MACHINE FOR STUMP ENGRAVING.

The invention consists simply in the employment of the principle of diminution, as gained by attaching two equal moveable arms, with tracing-points, to a graduated quadrangular vertical bar, which bar is suspended from an universal joint with screw-points. Fig. 1, A is the universal joint, B the bar, C C the two moveable arms and points.

The pillar or standard D, with its arm E, are merely accessory in this instance to the support of the universal joint, &c.; and the slide-rests F and G (G being placed transversely upon F, and F being screwed upon the two triangular bars H H, which pass through the sockets I I, thus enabling the side-rests to correspond in height with the required elevation of the upper tracing-arm,) are only necessary for a portion of the work which this instrument is capable of producing. J J are the heads of the binding-screws, which arrest the bars, and prevent the rests from sliding down upon the table.

The bar B, being thus suspended, will necessarily swing with perfect freedom in any direction, and, if the universal joint be nicely adjusted, without shake. Moreover, the arms with the tracing-points likewise swing upon their centres, being restrained from falling towards the bar by the intervention of their respective places of rest. When motion is given to the bar by the lower tracer, as it moves upon the object designed to be reduced, the upper tracer by its means imitates that movement at a diminished rate, according to the distance that may exist between them.

The following are data for further investigation. Vertical bar, twenty-two inches; tracing-points, their distance from the bar, five inches; the angle of the tracing-arms, of which the bar forms the base, five degrees; and, when the lower tracing-point is at the further extremity of the drawing, the bar to be then vertical; consequently, the movement will be from the centre of suspension, not round it. The plan of increasing the length of the bar according to circumstances, and preserving equal arms, with this subsequent arrangement of them, will be found preferable to lengthening the lower arm, which considerably increases the vibration. And when the reduction of one half only, together with the combined incorrectness of both surfaces, namely, that of the prepared plate, and of the design from which the transfer is to be made, are taken into consideration, the result may be considered favorable.

As it would be inconvenient to use the machine in its present form for large plates, the machine should be moveable above the plate; and, for the lettering of maps, and detached portions of work, a very simple modification would suffice. The tracers for this purpose may be inverted, affixing them to the ends of the vertical bar, and passing that bar *through* a universal joint: the joint has a stiff arm connected with a sliding-piece, which permits it to move when necessary upon a standard with a loaded foot. The tracing-points in this instrument need not be displaced; for, by disconnecting the bar and joint at the same time that the binding-screw of the sliding-piece upon the standard is loosened, the universal joint can be shifted higher or lower upon the bar, which acts as a lever upon its fulcrum. This is the construction of the joint: a sliding-piece upon the bar suspending a square or circular frame of metal at one of its diameters, is again suspended at its transverse diameter, by the stiff arm that is made to slide upon the standard, which standard must likewise have an arm, with a small skeleton table, for lightness, connected with its head, for the purpose of supporting the channelled type, or other original, to be brought under the upper tracer, which is here the prime mover, and by which the copy is transmitted. The standard must be placed upon a plank, having at each end a narrow foot; this will leave sufficient vacuity to prevent injury to the prepared plate.

The diagram, Fig. 2, represents the machine at right angles to that shown in Fig. 1.

A A is the base, or table, which supports the whole superstructure; C C is the standard (marked D in the engraving) which carries the graduated bar G G (B in the engraving), suspended from the arm D (G in the engraving) by means of the universal joint E F (A in the engraving); H I are the two arms, the lower one carrying the tracing-point J, and the upper the etching-point K (these parts are indicated in the engraving by the letters C C); L is the table that supports the plate to be etched; N the slide-rest (F in the engraving) that moves the table on the bed O in the direction of its length, and P the head of the screw which actuates the other slide-rest (G in the engraving), by means of which the table is moved in the direction of its breadth; R is one of the triangular sockets (I in the engraving) in which the triangular uprights (H H in the engraving) slide; and S (J in the engraving) is one of the binding-screws, by means of which they may be secured at any required height.

PROCEEDINGS OF THE BRITISH ASSOCIATION AT GLASGOW.

(Resumed from page 208.)

SECTION B.—CHEMISTRY AND MINERALOGY.

PROFESSOR Graham was requested to take the chair, while the President read a paper "On the most important Chemical Manufactures carried on in Glasgow and the neighbourhood." The manufacture of iron, sulphuric acid, bleaching powder, or chloride of lime, alum made at Hurlet and Campsie, precipitate of potash, chromate of potash, tartaric acid, acetic acid, pyroxylic spirit, iodine, soap, bleaching of cotton cloth, Turkey red dyeing, glass making; cudbear and gas were enumerated, and the manufacture of them fully explained.

The second paper read was by Mr. Connell, "On the Voltaic decomposition of Alcohol." The author endeavoured to show that by dissolving a small quantity of potassium in pure alcohol, and then subjecting the compound to voltaic action, water was obtained.

Dr. L. Playfair read the next paper, which was by D. R. W. Glover, "On a new process for obtaining Hydrobromic Acid, and Hydriodic Acid." The author proposed the employment of bromite and iodite of bromine as a very convenient source of the above named hydrobromic, in atomic proportions.

Professor Bunsen read the next paper, which was on the compounds of a new radical compound, called "Kakodyle." The process by which this compound is obtained is exceedingly dangerous, and the author, in his experiments, has been several times severely injured. Arsenic is a principal ingredient in this compound.

The next paper read was by Dr. Mohr, on a new mode of preparing Morphia. The principal of the new method of preparing morphia consists in dissolving the morphium in caustic lime by means of heat, and precipitating the filtered liquor by muriate of ammonia. The lime is neutralized by the muriatic acid of salt, ammonia set free, and the morphia precipitated. In this process the morphia is obtained in a crystalline and very pure state, without the alcohol. This mode of operating is as follows:—The opium is dissolved in boiling water and strained, this operation repeated twice, the liquors concentrated by evaporation, boiled with caustic lime, strained again, and mixed while hot with powder of sal-ammoniac.

Dr. Gregory said he had had a great deal of experience in preparing morphia, and he was quite satisfied that Dr. Mohr's was the best, both for preparing small quantities and for class experiments. He was sure it would be universally adopted as soon as known.

The next paper read was "On the peculiar odour evolved in certain electro-chemical decompositions," by Professor Schönbein.

M. Schönbein has undertaken a series of experiments, in order to ascertain the circumstances under which the odour is evolved in electro-chemical decompositions, the causes which influence its production, and, if possible, the principle to which its appearance is to be attributed. After describing the period at which the odour is produced, he goes on to observe, that the odour is evolved on the decomposition of water, dilute sulphuric acid, and many oxalates; dilute sulphuric acid yielding it in largest quantities. The author found, on collecting the oxygen gas evolved at the anode from a solution capable of evolving this odour, that it might be preserved for some time by inclosing the gas in well stopped bottles. From the characters possessed by this oxygen, he was led to consider the odour due to the presence of a minute portion of a new, and hitherto wholly unknown substance, of considerable importance in many natural phenomena; and he has therefore named it, from its most evident character, ozone. Its properties are as follows:—It is only evolved from solutions containing it, by perfectly clear electrodes of platinum or gold, while charcoal and the more oxydisable metals are unable to cause its appearance. It can only be obtained from a cold solution. When a piece of one of the oxydisable metals, such as lime, iron, &c., is placed in a portion of oxygen impregnated with ozone, that peculiar substance is almost immediately absorbed, and the oxygen becomes inodorous. When perfectly clear and dry plates of gold are immersed in oxygen containing ozone, they acquire a negatively electric state of polarity. The plates thus polarised continue their electric powers in air for a considerable time, but rapidly leave it when plunged in hydrogen gas, in which, if retained a sufficient time, they acquire an opposite state, becoming positively polarised. After comparing these effects with those produced by the odour peculiar to common electric sparks and brushes, he states that both from its electro-motive power, and likewise from its strong affinity to metals, it is evidently similar to chlorine, bromine, and iodine. Its non-appearance when water is decomposed by electrodes of the more oxydisable metals, he attributes to its entering immediately into combination with the metals; and he considered that when the solution is heated, the affinity of the ozone for metals is so much increased, that it is even able to combine with gold and platinum—thus accounting for its disappearance when heated. By this theory all the phenomena attendant on its evolution may be easily explained; and it hence becomes very interesting to search for traces of this widely-diffused substance. M. Schönbein considers the smell perceived whenever bodies are struck by lightning is probably due to a small portion of ozone being set free, and relates a case of a church lately struck by lightning, which fell within his own observation, in which the surrounding buildings to a considerable distance were filled with a blueish vapour and peculiar pungent odour. Even in this early stage of the inquiry, it will be readily seen that many curious and unexplained phenomena might be accounted for, if the existence of the supposed electrolyte be proved. M. Schönbein proposes devoting all his leisure to the prosecution of this inquiry, in the details of which he is at present engaged.

The Chairman said the paper read was only an abstract of Professor Schönbein's, which was considered more suitable for reading than the report itself. He did not observe whether anything was stated as to the properties of the new substance, (ozone.)

Professor Graham said M. Schönbein thought he had established an analogy between the new substance and chlorine, and the Professor explained the analysis upon which this opinion was founded.

The next paper read was by Mr. E. Solly, "On the best method of bleaching vegetable wax." Mr. Solly, after referring to a number of experiments which he had made during the course of the summer to discolorise vegetable wax, stated he found the following to answer the purpose most completely, by which the wax was bleached in a few minutes, and a greater effect of discoloration was produced than by the mere passage of chlorine for half an hour. This method consisted of bleaching by pure nitric acid, by melting the wax, pouring in a small quantity of sulphuric acid, composed of one part of oil of vitriol to two of water, and then stirring in a few crystals of nitrate of soda, the whole to be agitated with a wooden stirrer, and kept heated. Nitric acid is then evolved in considerable quantity and purity from a large surface, and in such a manner that all the acid evolved must necessarily pass through the melted wax. This method answers the purpose very completely, the process is cheap and rapid, and the residuum being merely a little solution of sulphate of soda, is very easily removed.

Dr. R. D. Thomson read a paper by Mr. Sturgeon, "On a peculiar class of Voltaic phenomena." The Section then adjourned.

Section G.—Mechanical Science.

Smoke Protector.—Mr. Wallace exhibited and explained his apparatus for enabling persons to enter places on fire without danger from smoke, by means of breathing through water. A box of tin containing the water is placed on the man's back with tubes connected, forming a ring round the body, and straps for the shoulders. A hood of M'Intosh cloth, glazed in front, is put on the head, and being attached to the side tubes, four gallons of water will enable a person to bear the densest smoke for twenty minutes.

Mr. Hawkins exhibited a small instrument, made by Mr. Bakewell, for taking the angle of the dip of strata, whether the surface seen is above or below

the strata. This is accompanied by a spirit-level, which can be placed above either the higher or lower limb of the "Anglo-meter," which has a scale of degrees at its apex. A small compass is attached to the spirit-level, to show the direction of the dip. The instrument was much approved of.

Mr. Smith, of Deanston, exhibited a model of a new plan of canal lockage, the advantages of which he stated to be that the descent in each lock would not be more than twelve to eighteen inches—that the locks were opened by the passage of the vessels—that the locks shut of themselves—that the vessels did not require to stop—and that little or no water was lost. The lock-gate is hinged at the bottom, the upper portion, which is round, floats at the level of the higher part of the water, and is pressed down by the bow of the vessel in passing, and when it is passed rises to its former position. Mr. Smith stated, that a trial was to be made on the Great Canal.

Mr. Fairbairn read a paper on the strength of iron, with a view to test its applicability to the purpose of ship-building. Mr. F. detailed, at great length, the results of a variety of experiments made by him to determine the force requisite to overcome the cohesion of iron plates by a direct tension strain, but as these were given in a tabular form we must confine ourselves to one or two specimens of the results. The plates were subjected to the tension of a given weight, suspended from the point of a lever, and weights were added gradually till the plates were torn asunder. The experiments were made in the direction of the fibre of the plates, and in the following instances with a plate of an area of forty-four inches, and one-fourth inch thick, it required to tear the first one asunder 25,400 pounds; the second 27,099; the third 25,662; and the fourth 26,500. These were all Yorkshire plates. Mr. F. went into the subject of the extent to which the strength of iron plates was affected by the rivet holes, and the general deduction made from his experiment was that there was a loss equal to about 32 per cent. A conversation followed as to the comparative strength and safety of iron boats, in which it seemed to be a general opinion that they were preferable to wood in these respects. Mr. F. was strongly urged, by several members, to give his paper to the public, from the valuable matter it contained on this question.

Mr. Hodgkinson then read a paper relative to a series of similar experiments made by him on the strength of iron pillars. It appeared from these, that a pillar, square at top and bottom, was about three times as strong as one rounded at the ends—that if the pillars were not placed perfectly perpendicular, at least two-thirds of their strength was lost—and that they were one-seventh stronger when swelled in the middle, like the frustrum of a cone, with the base in the centre of the pillar. A short conversation ensued, in the course of which Professor Wallace suggested, that Mr. H. should try the experiment with various curves, which that gentleman readily promised to do.

Mr. Fairbairn next exhibited a model of an engine for raising water, which he had suggested for the purpose of draining the lake of Haarlem, in Holland, which covered upwards of 50,000 acres. It was his opinion that this could be accomplished by the application of a Cornish engine, of from 200 to 300 horse power, attached to a scoop 30 feet square, the one end of which was made to move on a centre. In the bottom of this scoop, which was curved, were several valves opening upwards, on the side nearest the engine. By the descending stroke of the engine, this side was immersed in water, and filled through the valves. The returning stroke, or rather the weights attached to the other end of the beam, raised the scoop, and threw the water into a canal at a higher level than the lake. Such an engine as he proposed would lift 17 tons of water each stroke, and make seven or eight strokes a minute. The average depth of the lake was 10 feet. The engine was so constructed as to give the dipping end of the scoop a larger or shorter stroke as required.

A Member gave a short account of the mode adopted in draining some of the fens in England, which was done by an engine on Watt's principle, turning a kind of bucket-wheel, and raising the water into the adjoining river.

Mr. Hodgkinson produced a miner's lamp by a Mr. Clegg, near Oldham. It was in principle the same as that of Davy, but was inclosed in a triangular lantern with three bull's-eye glasses. The object was to get rid of the danger arising from the use of Davy's, which, should it fall or upset, let the flame through the wires, and caused an explosion. In this lamp that danger was obviated, as there were gauze on the air-hole of the lanterns; and it had this excellent property, that whenever there was danger the light went out.

Mr. J. Scott Russell said, the next paper was that of Mr. Galline, "On Safety Valves." He did not intend to follow Mr. Galline through the whole of his description, but would read that part which tended to illustrate his plan. Mr. Galline went on the general principles that the safety valves at present in use were not large enough, and his object was to allow a large surface, like the lid of a chest, to rise at once when the pressure below becomes great enough to force it up; so that, upon a great accumulation of steam, it will escape before any accident could take place. He meant, in fact, that a large valve shall open instead of a small one. As Mr. Galline had not submitted machinery for it, and the subject could not be adequately explained without a diagram, the Section would be content by its attention being called to a matter so important. There were no remarks made, and the paper was lodged.

Mr. Russell then took up the next paper, that of Mr. Wallace, "On extinguishing Fire in Steam-Vessels."

Mr. Wallace's principle, he said, might be explained by the following mode of applying it on board of the Levan steam-boat. On the cabin floor of the steam-boat, a space of ten feet by fourteen feet was covered with wet sand, on which was laid iron plates, and on which a fire was kindled of very combustible matter, consisting of old tar barrels, &c. The quantity of this material was about four and a-half cwt. A hose thirty-four feet long, two and a-half inches diameter, extended from the boiler of the engine to the cabin, and when the fire had been sufficiently kindled, so that the panes of glass in the windows of the cabin began to break by the heat of the flames, the steam was let in, and the doors of the cabin shut. The fire was extinguished in about four minutes. Several trials were made; all of them terminated in extinguishing the fire with the same success. On another trial, a metal pipe of a greater diameter than the hose was connected with the steam-boiler, and extended into the cabin. A small square hatch was cut in the deck immediately above the cabin, and through this opening

were lowered down into the cabin two moveable grates, each containing a blazing fire, well kindled, of about one cwt. of coals. The hatch on the deck and cabin doors were then shut, and the steam let in, and in fifteen minutes after the small hatch was opened on the deck, and one of the grates hoisted up, when the whole mass of the coal and cinder which had before formed a powerful fire, were found to be completely extinguished. This experiment was repeated twice, with perfect success. Mr. Wallace's plan for extinguishing fire by means of steam has been before the public for upwards of five years, during which time a great number of trials have been publicly made, several of them in the presence of the Lord Provost, Magistrates, Commissioners of Police, Agents of Fire Insurance Companies, and Civil Engineers, who all agree that steam readily and effectually extinguishes fire, and can be made to enter corners and crevices where water cannot be made to reach.

Mr. Russell said that now, when there were so many steam-vessels upon the Atlantic, the subject had become one of vast importance. The experiment had been repeatedly and successfully tried, and simply consisted of leading a hose from the boiler to any part of the vessel, and by inundating the portion on fire with steam, of at once extinguishing it. The very consciousness that such an apparatus was on board a vessel, would impart a degree of security and comfort in the midst of the Atlantic, which would be duly appreciated by all. Indeed, many vessels had already adopted it.

Mr. Wallace, to a question addressed to him, said that the hose was constructed of painted canvas, but strong silk unpainted would answer equally well.

Mr. J. Scott Russell then gave an interesting detail of his experiments on the temperature of most effective condensation in steam-vessels. His principle was that there was a temperature of the greatest effect, which might be readily obtained by ordinary calculation, and which, if acted upon, would result in a material saving of power. The subject gave rise to a considerable discussion, in which Mr. Taylor, Mr. Fairbairn, and other members of the Section, took part, and the subject seemed to be one of much interest, which is likely to be fully explained in the transaction of the Association.

A paper was then read from Mr. Ritchie, on the warming and ventilation of buildings, supplementary to a document on the same subject in Loudon's Encyclopædia. The paper detailed, at considerable length, the vital importance to health of properly ventilated apartments. His principle was to carry into effect a mode of ventilation which would operate without the intervention of servants, and to introduce a current of external air upon the heated air within. The subject was discussed at considerable length, and Mr. Hopkins, Mr. Jeffries, Sir John Robinson, and other gentlemen, took part.

Mr. Vignoles then called the attention of the Section to the construction of large timber bridges, with special reference to railways, and illustrated his proposition by the drawing of diagrams, upon the board.

Mr. Dick read a paper on a new railway wheel. It may be made of cast or wrought iron, and the channels are filled with wood; its advantages are, that it works much easier than those commonly in use, is less expensive, and can be easily repaired. Mr. Dick explained the wheel by diagrams. It had been in operation for some time on the St. Helen's Railway, bearing daily 5 tons in weight, and was positively in better order than it was on the first day it was brought into operation. On the Kingston and Dublin Railway the sleepers were originally composed of granite; but the tremulous motion was so great that they had to be changed to wood; now, had this wheel been in use, all this disagreeable motion complained of would have been obviated, and a large expenditure saved. It worked remarkably smooth, especially in wet weather, and the fastenings of the sleepers were not so much worn as by the present wheels.

The paper was received.

Mr. Jeffrey called the attention of the Section to a new hydraulic apparatus. Its principal properties were simplicity and cheapness; and each of the buckets employed would carry one hundred weight and a half of water. His attention had been called to the subject from observing the clumsy mode in which water was drawn for the purposes of irrigation in certain districts of India.

Mr. Smith, of Deanston, observed, that it was a decided improvement upon the old plan of the chain bucket.

Mr. Scott Russell read an interesting paper, with explanatory deductions, being observations on the proportion of steam power to tonnage; these were additional observations to those contained in a paper on the same subject, which had been submitted to the last meeting of the Association. His object was to define the exact proportion of power to tonnage, which would be most economical in a sea-going steamer from the one end of the year to the other. The result was reached by taking the average, and allowing for the time consumed by favorable voyages in good weather, and bad voyages in rough weather. He found that large vessels, reckoning for a whole year, consumed in proportion a less quantity of fuel than those which were smaller; this was an extraordinary result, considering the velocity of large steamers, and the disadvantages under which they laboured in bad weather. The rule to obtain the best proportion of power to tonnage in a given vessel was this:—Suppose they should know the distance between a port in this country, and a certain port in America, and that a vessel took so much time, and consumed a certain quantity of fuel in making the voyage in good weather, and took another period of time and a different quantity of fuel in bad weather. Then, having ascertained these, from the square of the velocity of this vessel in good weather, subtract the square of the velocity of the same vessel in the worst weather, divide the differences of these two by the square of the velocity in good weather, and the quotient, being multiplied into double the horses' power of the said vessel, will give the power requisite to propel her in the same circumstances with the smallest quantity of fuel. Let us take (said he) a transatlantic steamer with 1 horse power to 4 tons—her bad voyage being 22 days, and her good 14 days; if we were about to build such a vessel, should we continue at the rate of 1 horse power to 4 tons, or should we alter it? Suppose her to be of 500 tons of actual horse power, then, should we increase or diminish it? The rule I have laid down would say that her power ought to be increased in the proportion of 12 to 10, or 6 to 5—that is to say, the engines of 500 horse power ought to be made of 600. By adding the hundred the following results will follow:—The vessel of less

power, by this formula, will burn 30 tons of coal per day, and in good weather do the distance in 14 days, burning in all 420 tons of coal. Her bad weather voyage will be 22 days, burning 660 tons of coal—still at 30 tons a-day. The vessel of greater power would burn 36 tons of coal per day, and make her voyage in 12½ days, burning in all 468 tons. This was a loss of 48 tons at first sight; but it was only an apparent loss. For let us come to the adverse weather, and instead of taking 22 days to complete her voyage, she will do it in 17½ days—burning 630 tons of coal; so that in this view of the case, she gains 4½ days in point of speed, and burns 30 tons less of coal than the vessel of 100 tons less power. But then it may be said that this is only one voyage, and this vessel will have more coal in the year than the other. They must, however, remember that no one knew when the bad weather would come, and she must always carry a quantity of coal prepared for it. Mr. R. then reasoned at some length in favor of his views, from the deductions he had laid down.

Mr. Fairbairn spoke briefly on the point. He had been in the Mediterranean last year, and was sorry to see the English vessels so much deficient in power. The French steamer passed them by two miles an hour. He was an advocate for increased power.

Mr. Smith, of Deanston, then submitted to the Section a new and improved mode of draining railway slopes and embankments.

Mr. Mallet gave in some explanation on the action of air and water on iron.

Mr. Vignoles read a paper by Mr. Grimes on Dunnet's rockets for preserving lives in case of shipwreck.

Dr. Wallace read a paper on Arches, with explanatory drawings.

Mr. Hawkins detailed Mr. Rengeley's new plan of the safety rotative railway, in which the wheels are proposed to be transferred from the carriage to the road, and the train to be moved by the revolution of the wheels, of which there will be 1760 upon the mile.

Mr. Alexander explained to the Section his Electro-Magnetic Telegraph.

OIL COLOR CAKES.

A convenient preparation for the use of artists, invented by Mr. George Blackman, for which that gentleman was awarded a medal by the Society of Arts. "Take," says Mr. Blackman, "of the clearest gum mastic, reduced to fine powder, four ounces; of spirits of turpentine one pint; mix them together in a bottle, stirring them frequently till the mastic is dissolved: if it is wanted in haste, some heat may be applied, but the solution is best when made cold. Let the colors to be made use of be the best that can be procured, taking care that by washing, &c. they be made as fine as possible. When the colors are dry, grind them on a close hard stone (porphyry is best) in spirits of turpentine, adding a small quantity of the mastic varnish; let the colors so ground become again dry, then prepare the composition for forming them into cakes in the following manner:—Procure some of the whitest and purest spermaceti you can obtain, melt it over a gentle fire in a clean earthern vessel; when fluid, add to it one-third of its weight of pure poppy oil, and stir the whole well together: these things being in readiness, place the stone on which your colors were ground on a frame or support, and by means of a charcoal fire under it make the stone warm; next grind your color fine with a muller, then adding a sufficient quantity of the mixture of poppy oil and spermaceti, work the whole together with a muller to a proper consistence, take then a piece of a fit size for the cake you intend to make, roll it into a ball, put it into a mould, press it, and it will be complete. When these cakes are to be used, they must be rubbed down in poppy, or other oil, or in a mixture of spirits of turpentine and oil, as may best suit the convenience or intention of the artist."

ON BISMUTH, FUSIBLE METAL, AND METALLIC PENCILS.

Bismuth, as it is called in chemical books, is usually known by the name of tin glass among workmen; apparently a corruption of the French vulgar name, *etain de glace*, tin for silvering glasses: as the name bismuth is of the *weiss muth*, or white mother, that is to say, of silver, of the German miners.

This is a rare metal, and of very little importance, as its uses are extremely slight. It is dug out of the mines of Schneeberg and Freyberg, in Saxony, where it is generally found in its proper metallic form, in the form of trees, inclosed in a reddish-brown jasper. It is very rarely pure in this state, but usually contains a little cobalt, and more or less arsenic.

From the easiness with which bismuth melts, its extraction is easy and cheap. It requires nothing more than to break the ore, to put it into large melting-pots, and surround them with lighted billets of wood; the bismuth melts, runs down, and forms a cake at the bottom of the pot. This is the method used at Freyberg; but sometimes, when the stony matters are in large proportion, it is necessary to add a flux to melt them.

At Schneeberg, the miners use a different method, which is very ingenious. A number of cast-iron pipes of sufficient diameter are placed across a furnace, with a gentle slope, so that when the metal melts it may run out at the lower end, which is partly stopped with a lump of clay, that has only a small hole left in it, through which the bismuth runs into a cast-iron cone. The upper end of the pipes are closed with a stopper of sheet-iron.

When bismuth is supposed to contain arsenic, the smelters keep it melted in a gentle heat for some time, that the arsenic may fly off; the heat must be very moderate, or the bismuth itself would also be volatilised.

Bismuth is sometimes, in mines, combined with sulphur, and sometimes in the state of oxide; but these ores are seldom or never smelted.

Bismuth is brittle, but may, by great care, be made to spread a little under the hammer. Although white, like regulus of antimony, yet its color is very different, as it has a yellow brassy tinge, where the regulus is blue; and it is so easy to melt, that it runs even in the flame of a candle. It is 9 times ·822 as heavy as an equal bulk of water.

The flakes of bismuth are large, and disposed parallel to the faces of an octahedron. When pure,

no metal is so easily obtained in the form of crystals, which are groups of cubes. To produce these crystals it is sufficient to melt it in a covered crucible, and to give it a good heat, in order to get rid of any arsenic that it may contain. It is then to be poured out into a warmed black melting-pot, having a hole in its side close to the bottom, stopped with a peg of wood. As soon as the bismuth has set at top, the peg is to be pulled out, that the liquid part of the metal may run out; when the under part of the solid crust of metal, on being turned out, usually exhibits very fine crystals.

Nitric acids, such as Glauber's spirit of nitre and aquafortis, dissolve bismuth with great ease; and as any arsenic that it may contain is reduced to the state of an arseniate of bismuth, which being not easily soluble, remains at the bottom of the vessel: the clear liquor contains only the pure bismuth.

This nitric solution of bismuth does not bear dilution with water; for on the adding that liquid to it, a white sediment falls down immediately, formerly well known by the name of pearl white, and now considered by some as an oxide of bismuth, and by others as a subnitrate of that metal. This pearl white was in great use as a cosmetic paint for the skins of the fair, but was subject to become suddenly black by coming in contact with certain vapours, by which several unfortunate accidents have happened to those ladies who used it, which have occasioned it to go out of use for this purpose: of late it has been used in medicine, and is now added to the new Pharmacopœia, published by the College of Physicians of London. It has also been used as a flux for the composition of enamels, making them more easily melted, but not giving them any color. In the making of sealing-wax it has, from its whiteness, been used for diluting the colors given by other drugs. But in this particular use it is thought preferable to dissolve the bismuth in aqua regia instead of pure nitric acid, because the submuriate, or subchlorure, according to other theorists and nomenclators, is more easily melted than the subnitrate. Pearl white, well washed with water, and mixed with a fifth part of gold powder, is used to gild porcelain.

Some assayers have proposed to use bismuth instead of lead, for the purpose of assaying silver by cupellation; but as bismuth is dearer than lead, and does not seem more advantageous, it has not come into use.

The principal use of bismuth is to form a few compound metals. Like cast-iron, it expands as it passes from a liquid to a solid state, hence it takes its very sharp impressions from the moulds in which it is cast. It is this property of bismuth that occasions the letter-founders to use it in their metal for small-sized types, as it produces a clearer faced letter and sharper impression than could be obtained from the lead antimony only, of which the larger types are, for the sake of cheapness, composed.

There is another use made of bismuth, which, until lately, served only for the purpose of amusement. When added to a mixture of lead and tin, it causes them to melt with a very low degree of heat. Equal quantities of these three metals may be melted in a bit of paper over a candle, without burning it: but the mixture that melts with the smallest heat is that of eight ounces of bismuth, five ounces of lead, and three ounces of tin, which melts at 202 degrees of Fahrenheit. Hence toy-spoons are made of them; which being given to children to stir very hot tea, melt while they are using them. Parkes has proposed the use of these compounds of lead and tin with or without bismuth, in certain proportions, to form metallic baths, in which cutlery may be immersed for the purpose of tempering it always at the same precise temperature.

Metallic Pencils.—Another use of this fusible alloy, as it is called, is for making metallic pencils, to write upon paper, prepared by having burnt hartshorn well rubbed upon it. The marks are as fine as those of black lead pencil, and not so easily rubbed out. This is a very good article, and memorandum books of this kind are very convenient, being equally ready for use with black lead pencils, and yet as permanent as ink.

BOOKBINDING.

(Resumed from p. 206, and concluded.)

VELLUM binding, as was before observed, is the term applied to the binding of every species of account book. The first step is to fold and count the paper into sections, which in foolscap generally consists of six sheets; above that size, of four sheets, which are sewed upon strips of vellum. Small books, up to foolscap folio, usually have three strips; above that size the number is increased. Account books are sewed much in the same way as printed books, except that vellum slips are used in lieu of the cords, and a much stronger thread and wax are employed. After sewing, the first ruled leaf at each end is pasted to the waste paper, and the marble paper lining introduced; the back is then glued in the usual manner. When the glue is dry, the fore-edge of the book is cut, and the back rounded, a deeper hollow and rounder back being formed in account books than in printed ones. The two ends are then cut, and the edges marbled. The head-bands are worked on a slip of stout board, as before described, care being taken in this instance to form a deep narrow, rather than a round band. Strong pieces of canvas or buckram are then glued at the top and bottom of the back, and between each of the vellum slips. A hollow back is prepared by taking a slip of milled board, about a quarter of an inch wider than the back of the book, and soaking it in water; it is then glued on both sides, and left in this state for about ten minutes: having been laid on a sheet of paper, a roller corresponding in dimension with the back of the book is placed upon it, and the whole worked backward and forward on the roller, which gives the milled board a semicircular shape; it is then dried hard before the fire. Another method, which is a very good one, and frequently adopted, consists in taking a roller (an assortment of the most useful sizes being kept for the purpose), and winding round it thick paper and wrappers well pasted, until the requisite thickness is obtained; the roll is then thoroughly dried and divided longitudinally, which forms two good firm semicircular backs. Milled boards of a thickness proportionate to the size of the book are then taken, and the fly-leaf of the book being pasted, the board is laid on in its proper place; the same course is also pursued with the other side. It is customary with large books to use two thin boards pasted together, instead of one thick one: in this case the vellum slips on which the book is sewn, are inserted between them, which adds greatly to the strength of the binding. After the boards have been squared, the back, formed in the manner described above,

exactly fitting the back of the book, is placed upon it, and a piece of canvas being cut sufficiently large to extend half the width of the back on one side of the book to the same distance on the other side, is glued on the boards and over the back, which contributes to strengthen the book, and hold the hollow back firmly in its place. The back is sometimes formed of sheet iron, which, in large books, is an improvement: this kind of back was first introduced by Mr. John Williams, who took out a patent for his invention. The book is now ready for covering: the leather for the cover is carefully pared all round, and put on as before described under the head of Bookbinding. The covers mostly used by vellum-binders are forril and vellum, white and colored; smooth and rough calf and sheep; basil, smooth and grained, and Russia; in any of which books may be either whole or half-bound. Forril and vellum covers are lined with paper and pressed smooth; when dry, they are fitted on the back, and creased in the joints; the boards are then pasted, and the covers pressed on them; when dry, the edges of the cover are pasted and turned in, and the book again pressed; the cover is then washed with a sponge and paste-water, and then ruled off. If the cover is rough calf or sheep, it is dressed with pumice-stone and a clothes brush. Smooth calf, basil, &c. are glaired and polished as described in bookbinding. Rough calf books are usually ornamented by passing a roller round the edges and sides of the cover, with sometimes an ornament added; for this purpose, the tools must be used nearly red hot. To increase the strength of large books, they sometimes have, in addition to the leather or vellum cover, bands of Russia leather, which are worked on with thongs of vellum, and give the book a very neat appearance. The lettering of account books is precisely the same as before described.

STUFFING AND SKINNING ANIMALS.

Before we begin to skin an animal, we must fill its mouth with flax; if there be any wound capable of letting out blood, cotton or tow must also be introduced into it: this done, we stretch out the animal on its back, and taking precisely the middle of the abdomen, turn back the hairs to the right and to the left, and open the skin in a line from the arch or hollow of the pubis to the stomach. Then disengage the anus, and separate it from the rectum; and separate each thigh at its union with the pelvis, cut off the arms at the shoulder joint, and the ears as close as possible to the skull, being particularly careful not to injure the eyes or nose. Then separate the head from the trunk, and clean the bones: the brains, &c. may be taken out by the occipital hole. The head being thus well cleaned, it may be replaced in the skin. The legs being drawn out of the skin as far as possible, remove from them all the flesh, and return the bones into their places. It is now ready for stuffing.

To stuff the animal proceed thus:—Take an iron wire, the length of the tail, having one end turned into a ring, to be within the body; cover this wire with tow or cotton, and put it in its place. Finish the legs in the same manner; stuff the skull also, and thrust a wire through the nose and along the back to the tail, to which the wire of the legs and feet may be fastened; then stuff the body, sewing it up as you proceed: afterwards bend the limbs at the articulations, place in the enamel eyes before the skin is dry. Then arrange the lips, and fasten them with pins: we are often obliged to support them with cotton, especially when we wish the mouth to be open, and be sure and place some cotton tightly into the nostrils. To place the ears properly, if we would have them upright, we pass a connecting thread through their base, and tighten it till they are sufficiently drawn together. If the animal has large ears, like the hare, it is good to put a piece of pasteboard within, having the form of the ear, fastening it with small pins at the edges; a thin piece of cork is preferable. We may generally employ this method for all animals, from a mouse to a tiger; some species require other precautions, as

The Bat.—After stuffing the body without wires, extend them on a piece of cork, extend the wings, and fix them very equally with pins; when dry, they will retain the shape given them.

The Lemur volans (Flying Squirrel).—This animal being as large as a pole-cat, and not having wings like the bat, but a sort of mantle, which they extend by the extremities of the four legs, pins are insufficient to fix them, and we use wire as with other quadrupeds. They are very rare, and only found as yet in the Molucca Islands.

Hedgehogs, are mounted by the usual methods, except that it is stuffed a little less than usual to ensure bending. Sew it up without putting in any wires, and it will be sufficient to draw the head and four feet together under the middle of the belly, to roll it into its accustomed ball. Then, to preserve this form, place it on its back in the middle of a cloth, and tie the corners together crosswise, and hang it on a hook in the air to dry. Some beautiful species are found in Madagascar.

Hares.—If we wish to mount a hare sitting, a wire must pass from the anus into the board upon which it is fixed.

Beavers ought to have the back very round and short; we cut the tail underneath, remove all the flesh, and replace it with chopped flax.

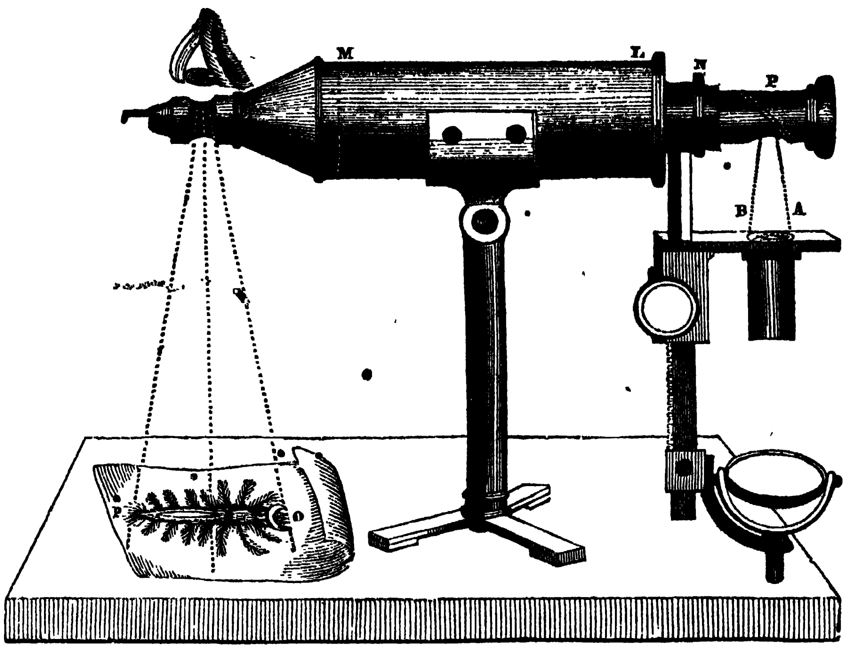
Ant-eaters.—The great ant eater has a tail like the long beard of a feather pendant on each side of the stem, and raised upon the back. Cut it longitudinally to skin it, and the tail bearer must be much longer than that of other animals; it is also necessary to make the tongue come out, which is very long in this species.

Armadilloes.—These animals do not require any preservation, because they are destitute of hair.

Deer.—The horns with which the head is ornamented, will not allow us to skin these animals in the usual manner. When you reach the neck cut it off as closely as possible to the head, and make another opening in the skin, beginning under the chin; continue this cut so as to be able to take away the tongue and brains, and the remainder of the neck, &c. Cut the lips as near as possible to the jaw-bone, and continue ascending towards the forehead, and take away the skin entirely from the head, except at the root of the horns. Then clean the head well, stuff it, and place it again within the skin, and sew it up with very fine stitches; then cut under the chin, and proceed as in other animals. All other

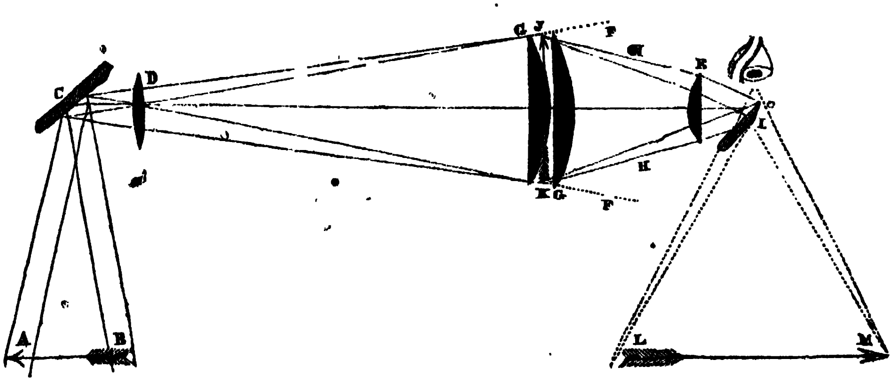
Horned Animals should be skinned like the deer.

Fig. 1.



VARLEY'S GRAPHIC MICROSCOPE AND TELESCOPE.

Fig. 2.



VARLEY'S GRAPHIC MICROSCOPE AND TELESCOPE.

(As described by Mr. Varley to the Society of Arts, and published in their Transactions.)

In order to make this instrument better understood, I will first show its difference from the previously known and really excellent instrument, the camera obscura; then explain its mode of action; thirdly, its construction; and, fourthly, the various purposes to which it may be applied.

Most persons know that the camera obscura is formed with a plain mirror and a lens, which projects a picture on paper; but to render that picture visible, the whole space from the lens to the paper requires to be inclosed in a dark chamber, so as totally to exclude all other light; hence its name. Images of any size, and of great brilliancy, may be formed by this instrument, if we use a large plane metallic speculum, and lenses of sufficiently long focus, and so well constructed as to bear, and have, the largest possible aperture. The distance of the lens from its focus is the perspective distance of the picture which it produces, or, in other words, is the distance of the station-point from which that picture should be viewed; because it then appears exactly of the same size as the original objects.

A camera obscura may be constructed to give images of all the most useful sizes at a moderate price; yet the expense and trouble of moving it from place to place, and its high and broad surface enabling the wind to interfere with its required steadiness, are objections to its general adoption.

The image given by a telescope is subject only to few of these objections. The size of the image does not depend on the focal distance of the object-glass, but on the proportion between its focal distance and that of the eye-piece; and the brightness of that image depends, within certain limits, on the diameter of the object-glass. Therefore, a small telescope will give an image as big as a large camera obscura; but it will not project that image on paper, and, as we usually look into the telescope to see the image within the tube, it cannot be transferred to paper by tracing. In my graphic telescope I have contrived to place the image apparently outside of the tube; and, although not actually projected on any surface, yet the observer receives the rays from the telescope into his eye in such a manner that they may be made to appear to come from a sheet of paper suitably placed for the purpose; therefore, this image may be traced on the paper. The size of the image may be varied very considerably without altering the size of the apparatus: sketches, therefore, on a very large or very small scale may be made by the same instrument; and as it never requires any additional height, or any shade to exclude day-light from the image, it offers no broad surface to be affected by the wind, and thus be rendered unsteady.

The image which we are enabled to trace with my instrument is a telescopic one; and I will now show how that image is produced. Fig. 2 is a diagram of one of the smallest graphic telescopes, half the real size, containing all the optical portion freed from the surrounding tubes. Let the arrow A B represent an object to be drawn; in this instance it is a near one, the instrument being used as a microscope: C is a flat speculum placed at an angle of 45° with the axis of the telescope; it receives the various pencils of rays which diverge from every point of the object, (to avoid confusion, only the middle and two extreme ones are shown), and reflects them to the double convex object-glass D: this is sometimes made with two such lenses; but the larger instruments have achromatic object-glasses; in all cases, the thinner the object-glass is the better: the object-glass refracts the various rays about its focus, so as to form the curved image J K: here these rays will cross and diverge, and are to pass through the eye-lens E, which will render them so nearly parallel as to give distinct vision of the image, the eye-glass being placed so that its focus just meets that of the object-glass. But though the central pencils of rays would proceed to the eye-lens E, it will be seen that the outer pencils would pass on in the direction F F beyond the diameter of the lens E, and be lost: to prevent this, another lens, or two equivalent ones G G, must be placed on the image J K, where the rays cross. A lens so placed does not affect the crossing of the rays, but it deflects each pencil in mass towards the axis, from the course F F into the course H H, where they will arrive at the eye-lens E, and by it be refracted at a still quicker rate towards the axis, and rendered nearly parallel. These pencils are all of the same size, and meet together in the axis, where, if the eye is placed, it can receive them all, and will then see the whole area of the lens filled with the image: this area is called the field of view; and because the lens G greatly increases the diameter of that area, it is called the field-glass. The pencils all meeting together, a cap with an eye-hole of the size of one pencil is usually put there, that being large enough for them all to pass through to the eye.

It will be seen that the image J K is convex about the object-glass as a centre, whilst the eye-glass evidently needs the image to be concave, to shew every part distinct at the same time: this evil would much lessen the field of distinct view if there had not been means both of correcting it, and another evil of as great magnitude, which I will now state, and then shew how to correct them both. This second evil is, that the image formed by the object-glass is larger as it approaches the circumference than at the centre, a square being shewn like a pin-cushion; so that, instead of right lines, the four sides will be curved inwards: and the eye-glass, also, has the same fault, magnifying the circumference more than the centre, and thus increasing the evil.

If the field-glass G is removed from the neutral point,—namely, that where the image is formed, or where the rays cross, and the two focuses meet,—and is placed nearer to the eye-lens, it will combine with it, and increase the magnifying power; but, if it is put nearer to the object-glass, it combines with that to shorten its focus, rendering the image less, and so diminishing the power. In shortening this focus, the rays converge more, and, after crossing, diverge more: this greater divergence will spread them over a larger portion of the eye-glass, and thus contribute to enable that lens to refract them parallel, but it will not quite do it; they will, therefore, require a still larger area of that lens, and that is only to be obtained by removing it a little further off, by which the rays will take area enough to be refracted parallel.

The various pencils of light, after passing through the eye-glass E, are to be directed upwards into the eye; therefore, a second flat speculum I is placed before the eye-glass at an angle of 45°, so as to receive all the pencils just as they meet together, and reflect them upwards into the eye. As the eye

is to be put where all the pencils meet, there must be no portion of speculum higher than that little circle of congress; and as a portion of the eye is to be allowed to look over the edge of the speculum, its upper edge is ground as thin as can be done with safety. This completes the optical part of the instrument. If we now look downwards into the eye-speculum, and leave a portion of the eye to look over its edge toward the arrow L M, where the drawing-paper is placed, we shall receive the rays from the telescope in exactly the same direction and divergence as those that enter the eye from the paper, and both image and paper will be seen together distinctly, and will allow that image to be correctly traced on the paper. When drawing with this instrument, the eye can be so placed as to remove any portion of the image from the lower part of the paper: the pencil is best seen in this lower margin, where the image is beginning to disappear. For the sake of room in the engraving, the image L M is placed too near: in proportion to this diagram, that image would be nine inches below the eye-piece, and five times as large as it is drawn.

A telescopic image has an advantage over others, in that it can be placed at any required distance from the eye, and thereby be rendered distinct to any sight: and this is an important feature in the graphic telescope; for it allows us to place the paper at the most eligible distance from the eye, and then, by adjusting the telescope, to bring the image to exactly the same distance, when the pencil, or crayon, and the image will both be seen together equally distinct; and then both eyes may be open to see the pencil, though one only sees the image. When the eye-piece is drawn away from the object-glass to the utmost extent compatible with seeing the image of a given object distinctly, the rays from the eye-glass which enter the eye are parallel, and the image appears distant, so we cannot place the paper far enough to see both together; but by pushing in the eye-piece a little, the rays will diverge a little, as though they came from a nearer object; and if we push in the eye-glass as much as we possibly can, consistent with distinct vision, the rays will diverge as from the very nearest object that can be seen distinctly, and the paper would require to be placed as close to the eye as it could possibly be seen distinct. It is a very small distance that we have to move the eye-piece to produce the extreme effects; therefore, when good vision is obtained, it is easy to adjust the instrument so that the rays shall diverge exactly as much as those which come from the paper. The dotted rays from the arrow L M show the divergence of those that proceed from the eye-glass against the speculum and into the eye, and thus make the image appear to be at that exact distance. When I wish to make an extremely small copy from a large picture, I do not effect the whole reduction by giving the required distance to the picture, for ordinary rooms do not allow that distance; but I place the picture as far as I can, and do the rest by using spectacles, the focus of which is so short as to let me see the paper when placed so near as to reduce the image to the required size. This diagram represents the instrument in use as a microscope; for the object P O is near, and the image L M is larger than it; but the object-speculum C is made to revolve on the axis of the telescope, so, if it is turned a quarter round, it will receive rays horizontally from objects at any distance.

With a graphic microscope we may trace an image much larger than the stated magnifying power, for ten inches is the distance at which the magnified image is measured, and though we sometimes trace within that distance, yet I usually draw at the distance of eighteen inches, which makes the image four-fifths larger.

Having now described a stationary graphic microscope, I will show how the telescope may be used as a microscope: premising that whenever it gives an image larger than the object it is a microscope, and that, though a telescope magnifies most with an object-glass having a long focus, it is the reverse with the microscope; for that magnifies most with a short object-glass, and the further that is placed from the eye-piece the greater will be the power.

The telescope, Fig. 2, being suited to receive either a four or an eight-inch object-glass, I put the shortest one in, and pull the tubes out the full length, which is rather more than double the focus; therefore it will require the object to be placed within eight inches distance from the object-glass, to enable it to give an image at the eye-piece. This image will bear exactly the same proportion to the object as their respective distances are from the object-glass; in this case it will be a little larger, and the eye-piece will magnify the image about six times; and if the paper on which the image is traced be more than ten inches distant from the eye-piece, it will be still larger, so that this combination will make a miniature of one inch appear as large as life. I sometimes lay the object on the table or drawing-board, like P O, Fig. 1, because then the same board will hold all together quite steady, and gradually raise it till its image is given large enough. If the object is placed vertically on either side of the object-speculum, the instrument may be slid on the table to or from it till correct vision is obtained: even here, that all may be held together, I prefer clamping this side-support to the board. In this, as well as in a telescope, the image will be gradually lessened if we gradually increase the distance of the object, and gradually slide in the object-tube to regain distinct vision, so we can always choose the exact size that is most eligible. It is obvious that, by using object-glasses of shorter focus than those provided for the telescope, we may carry on the power till it equals the stationary microscope.

I will now show some of the advantages obtained by using this graphic telescope: premising that instruments not being masters, they cannot make artists of those who want the necessary previous knowledge and practice; but my instrument is a most excellent servant, and one that will greatly facilitate the progress of an artist.

In the first place, it sets him quite at liberty in the choice of the distance from which he will take his view, and also in the size of the sketches; for without such help we are frequently obliged to go much too near in order to see the leading features, and thus, by the violence of the perspective, lose much of the grandeur and true proportion. With my telescope there is no distance from which an artist would choose a view, but what it will show distinctly, and of any size that he could wish. When a back-ground is mountainous, sketching further off brings them up in much grander proportion, and thus the telescope finds numerous fine views that before were unnoticed; intervening objects hiding them from a near view, and sometimes water removing us too far to see them large enough to

claim our attention. In thus drawing attention to more distant views, I do not mean to neglect the grand and imposing effect so often obtained by a near view, where the artist is enabled, by the rapid increase or decrease of the perspective, to alter so much the apparent proportions of the object, as to render it greatly superior to its natural proportions as seen from a distance; but for these, drawing by the eye is frequently better than with any instrument.

This telescope will give all the views strictly correct, without any care or anxiety about the perspective; it is therefore very valuable for drawing shipping and boats, the various curves of which cannot be known, yet are hereby given quite correct. Trees may be drawn more correctly, and with much more of the details, than otherwise we should have patience to attend to. Indeed, all local objects,—waggons, and the various implements of husbandry, which must be had, and yet are scarcely worth the trouble, animals, figures, and birds,—may readily be drawn; and by taking away the object-speculum, these objects or views may be drawn at once on stone the reverse way, and so be printed the right way: thus we may now publish real sketches from nature.

Wild or savage animals may be sketched from a place of safety, at such a distance as not to rouse or disturb them; also timid animals, which will not remain still if we go near them. In this case a good artist needs not always to trace; the image of the animal may be in one part of the field, and a copy made of it close by the image, which is a peculiar advantage when the object is in motion.

Portraits of any size may be drawn from life. To do this it is convenient to place the head of the sitter in contact with a V-shaped gap in a board, attached to the back of a chair.

The instrument is of great use for copying or reducing from statues or pictures, architecture or machinery. It also supplies with the greatest ease all those magnificent effects produced in mountain scenery by accuracy in geological details.

Artists may also employ mere draughtsmen to sketch correctly the inferior details for them, and thus save their time to attend to the nobler parts of the art. Few flowers remain in the same state long enough to be drawn correctly, with the lights, shadows and reflections, caused by sunshine: with this instrument that may be done. Also the most minute botanical or entomological specimens may be drawn as large as needful to show the particular details.

If this telescope, table, and draughtsman, were mounted on a polar axis, (a strong axis placed parallel to that of the earth,) and moved by a clock, a most perfect map of the stars could be traced, of any required size; for he would then direct his telescope to succeeding portions, as though they were all quite stationary.

PREPARATION OF PIGMENTS.

(Resumed from page 176.)

Periodide of Mercury.—Iodine, which is one of the elements of this color, is a simple substance discovered about thirty years since, in treating with sulphuric acid the sea-water of the soda of Varec. The name iodine is derived from the beautiful violet color which this substance takes when it is the state of gas.

At the common temperature it is solid, and has a metallic lustre resembling black lead; it volatilizes at the temperature of boiling water. Combined with the deutoxide of mercury it takes a scarlet color brighter than vermillion. In England this pigment is sold under the name of geranium red, and is used chiefly in water-color painting. The following process is one of the best for preparing this color:—Iodine and zinc (forming iodide of zinc) are first to be combined; for this purpose the zinc must be finely powdered, either by throwing it into water when it is melted, or by levigating it in a mortar until it loses its cohesion and can be easily divided.

The powdered zinc must then be put into a matrass with the iodine and distilled water, and, by help of a moderate heat, the iodine will combine readily with the zinc, and forms with that metal an iodide, which is then filtered.

Perchloride of mercury (corrosive sublimate) is then dissolved in distilled water; the two liquids are then mixed, and immediately a large quantity of precipitate is formed; this deposit is washed first with distilled water, and afterwards with filtered river water. The working of this color is of the greatest consequence, and must be done with peculiar care.

The Lakes.—This name was originally given to designate merely the purplish color called crimson, and when employed alone it always bears that appellation; but in its more extended sense it is applied to all colors prepared by combining a coloring matter or tincture with a basis which is commonly alumine: hence we have yellow, green, or violet lake.

The term itself appears to be of Indian origin. It is probable that the first lakes used in Europe came from India, and were made from the resinous lac so abundant in that country, which yields a purple coloring matter at present very essential in painting, because in many respects it takes precedence of cochineal.

It was first imported into England, where it is called, in commerce, *lac*, or *lac dye*. The people of India collect this resin, bruise it, and then boil it in water slightly alkaline, which separates the coloring matter; the solution is then precipitated with alum, and is formed into cakes and dried. This is the way in which it is imported.

Preparation.—The manufacturers commence this process by preparing that which is called "the white body of lake," which is composed of a paste of pure alumine, or of alumine and chalk, upon which the coloring matter being thrown, fixes itself in a manner more or less durable.

To prepare this paste, a quantity of alum is to be dissolved in water; and this solution is then precipitated by subcarbonate of soda or potass, * in the proportion of three parts of good potass to five of alum: it is easy to ascertain whether the whole of the alumine is precipitated without an excess of alkali; when the precipitate has fallen to the bottom of the vessel, some of the clear liquid should be drawn off into two glasses; into one of these is thrown some drops of a solution of potass, and into the other a little alum water; if the precipitation is

* Soda is preferable for this purpose. Four parts and a half of this material are required to saturate five parts of alum.

perfectly formed, no other subsidence will take place in either of the glasses; when the sediment is formed, the liquid is to be drawn off, and the deposit is to be washed with a great quantity of water, until at last it comes off without smell; it is then extended upon a filter of linen to drain, and when it is of the consistence of soft paste, it must be mixed with a warm decoction of cochineal, which colors it more or less strong, according to the quantity of coloring matter contained in the decoction; it only now remains to separate the lake from the surplus liquid, to wash and strain it through a filter, to put it into forms, and dry it in the shade.

As it happens that in the preparation of carmine, only a small quantity of the coloring matter is drawn off, and as the decoction from which it is extracted is still full of coloring matter, there is not any occasion to make a decoction of cochineal expressly for the purpose of making lake, as the residue of that used in the preparation of carmine will answer the purpose. This process is founded upon the particular affinity in alumine for vegetable and animal coloring matter; it is well known that alum is one of the best mordants in the dyer's trade. Alumine also serves as a basis for other colors as well as crimson:—for instance, in making yellow lake, it is only necessary to fix the coloring matter of woad, quercitron, Persian berries, &c. upon alumine, or on an aluminous base.

It is of the greatest consequence, that in the preparation of yellow lakes the alum should be pure; for a very small portion of iron is sufficient to injure the color; and that metal exists in the greater part of the alum of commerce. As for the common lakes from French berries, pure alumine is not used: the white body of these is only fine chalk, to which a little alum is added.

Alum by itself will form a precipitate with the vegetable decoctions: as, for instance, a very strong precipitate may be obtained by adding alum water to a decoction of woad; but it will also precipitate the mucilaginous and gummy matter, which this vegetable contains abundantly.

Brown Pink.—The drops made from English berries are dissolved with a strong decoction of the berries of Avignon (*rhamnus infectorius*): the mixture is filtered, and to it is added a solution of the subcarbonate of soda, one-fourth the weight of the berries; the tincture is then precipitated with a solution of alum, in such proportions as that the alkali shall not be more than half saturated; it must then be left undisturbed for twenty-four hours; the liquid must then be drawn off, and as it still contains much coloring matter, a smaller quantity of alkali to be added, and it is again precipitated with a similar proportion of alum: the precipitate is then washed, to carry off the salts.

In this process it is clear that one of the essential points is, that the alkali shall predominate. It is owing to this circumstance that the yellow color of the Avignon berries is turned to brown. By this process there can be obtained from yellow woad or quercitron bark a brown pink, which will be more lasting than the former.

To the drops mentioned may be given a green color, by using a solution of copper instead of alum; and it has been observed that the mordants from copper render the colors more lasting. In general, yellow lakes have little solidity; this is evident in many of the Flemish pictures, where the foliage has become blue from the yellow lake, with which the ultra-marine was mixed, having faded. Rembrandt made much use of this brown sort of pink: the alteration made by time, in the color when used in a full body, would not be observable; and there is some advantage in using vegetable colors in the shadows which lose part of their richness by the action of the air, and also because they are transparent, and cannot become black by time; and if mixed with colors which have a tendency to become darker by time, they mitigate it very much.

Red Ochres.—The appellation of brown red, which has been given to the red oxide of iron, is quite correct; it is, in fact, a red color somewhat lowered by a tint of brown.

We often find this color ready formed by nature; if by some means the water is evaporated which was in combination with the oxide of iron, the latter changes to the red color.

The rust of iron offers an example to us of this change of color: this rust, which is at first of a yellow ochre tint, turns brown on exposure to the air, and in time becomes red.

The greater part of the brown red used in painting, is made from yellow ochre calcined; it is supposed that on the purity of the ochres depends the brightness of the red thus obtained. Very fine brown red is also made by calcining sulphate of iron. Commerce has long supplied the arts with this color, which is prepared by the decomposition of sulphate of iron: the residuum is a red oxide, more or less violet according as the action of the fire has been more or less prolonged. This color is not only valuable for its lasting qualities, but also for the fine carnation tint which it produces with white: and we perceive in the works of Titian, Vandyck, and others, who have approached nearest to nature, that it is very much employed.

Tritoxide or Purple Oxide of Iron.—Iron at the highest point of its oxidation takes the violet tint: the color is dull but permanent, and except the purple of cassius, it is the only purple that can be used in fresco.

Greens.—Besides the green tint composed from the simple union of yellow and blue, there are others formed either by nature or by chemical combinations, such as malachite, oxide of chrome, green earth, mountain, Scheele's and Vienna green.

Malachite, and Mountain Green.—These two substances are carbonates of copper: the first is found in solid masses, formed by the constant dropping of water saturated with carbonic acid, and holding in solution the oxide of copper. The carbonate is thus formed in bulbous masses, the shades are more or less intense, but always of a bright green.

The hardness, as well as solidity of the malachite, is sufficiently demonstrated by the great number of valuable objects which for ages have been wrought in this material, and which have not lost any of their lustre. It is not unlikely, that from the commencement of painting it has been ground up and used as a color.

Mountain green, in like manner, is only a carbonate of copper, and being found naturally formed, in the state of a fine powder, the artists have always had it ready prepared to their hands, and no doubt soon took advantage of it. We see, in the most ancient miniature pictures, greens in a perfect state of preservation, which evidently are the natural carbonates of copper.

It is prepared artificially, by precipitating, with the sub-carbonate of soda or potass, a solution of copper; the result of this is an opaque color, the

greyish or pale tint, which is used in decorative painting. It is not near so bright as the natural carbonate of copper: but it is probable that it could be obtained quite similar to it, if the carbonic acid could be combined with the oxide of copper in any other way than by the double decomposition of the carbonic alkalies, and the solutions of copper.

(To be continued.)

JAPANNING.

The art of painting and varnishing, after the manner originally practised by the natives of Japan, in the East Indies. It is employed for the purpose of preserving and beautifying various articles, usually of wood and metal, as well as of paper, leather, and cloth, when they are properly prepared for the purpose. Those articles we most commonly find japanned, are pieces of household furniture, cabinet work, boxes of all kinds, trays, screens, &c., and, very generally, those articles made of any of the above-mentioned or similar materials, which it may be desired to preserve from moisture; and this it is admirably adapted to effect, from its drying very hard, and being impervious to water at all moderate temperatures, even to boiling in some cases; but it may be employed on any dry substance that is sufficiently inflexible to prevent the japan coating from being cracked or forced off. The true japan, or that said to be used by the natives of Japan and China, is a sort of varnish or lacker peculiar to itself. It is sometimes brought over to this country; but on account of the injury arising from its poisonous qualities, to those persons employed in working with it, is now seldom used. It is the juice of a peculiar tree growing in those parts, and is collected by making an incision into the lower part of the trunk of the tree, and placing vessels underneath to receive it. The juice has the appearance of cream when it first runs from the tree, but on exposure to the air it becomes black. It is prepared for use by submitting it to the action of the open air in shallow vessels, and is kept constantly stirred for many hours, so that by having all parts equally exposed, it may become of a uniform deep black. A portion of well-charred wood reduced to a fine powder is added, and it is then fit for use. The Japanese first spread it thinly and evenly over the body intended to be japanned, and then dry it in the sun. If necessary, another coat is laid on, and dried as before. It very soon becomes harder than most of the substances on which it is laid. As soon as it is sufficiently hard, it is polished with a smooth stone and water, until it becomes as smooth and even as a plate of glass, and then wiping it dry, it is ready to be varnished, except when figures or other ornaments are to be drawn on it in gold or silver: in that case, the form of the figures or other ornaments is to be traced on the work with a pencil, in the varnish noticed below. When this varnish is almost dry, the gold or silver leaf is to be laid on; the whole is then ready to receive the varnish, or finishing coat, which must be spread on thin, and as evenly as possible. This varnish is a particular sort of oil procured in Japan, boiled and mixed with turpentine. When any other color than black it desired, the proper color must be mixed with the varnish, and the whole spread on, particular care being taken that it be laid on evenly. The above is the method of japanning said to be practised by the natives of Japan. Our method differs from it considerably; it is less durable, but its practice is not so injurious to the health. We in some cases employ a priming or under coat for the purpose of filling up any inequalities, and making smooth the surface to be japanned; but at other times the priming is altogether omitted, the colored varnish or proper japan ground being applied immediately to the substance to be japanned. The former is the method that was usually practised, and still is, in those cases when the surface is very uneven and rough; but when the surface is smooth, as in the case of metals, smooth grained wood, &c., it is now always rejected. The advantage of using the priming or undercoat is, that it makes a saving in the quantity of varnish used, because the matter of which the priming is composed fills up the inequalities in the surface of the body to be varnished, and makes it easy, by means of rubbing and water polishing, to procure an even surface for the varnish. This was, therefore, such a convenience in the shape of rough and uneven surfaces, that it became an established method, and is still retained in many instances. There is, however, this inconvenience always attending the use of priming or undercoat of size and whiting, that the japan coats of varnish and color will be constantly liable to be cracked and peeled off by any violence, and will not endure near so long as the bodies japanned in the same manner, but without the priming. This may be observed easily by comparing those articles that have been some time in wear, especially snuff-boxes, in the japanning of which the priming has been used, with those in which it has been omitted; the latter never peel or crack, or suffer damage, unless by great violence, and such a continual rubbing as wastes away the substance of this varnish, while the japan coats of the former crack and fly off in flakes, whenever any knock or fall, especially at the edges, exposes them to injury. The Birmingham manufacturers, who originally practised the japanning only on metals, to which the reason before stated for the use of priming did not apply, and who took up this art of themselves, as a new thing, of course omitted at first the use of any such undercoat, and not finding it more necessary in the instance of *papier maché* and some other things, than on metals, continue still to reject it; on which account the boxes and other articles of their manufacture are, with regard to the wear, much better than those on which the priming is still used.

Having thus noticed the method usually practised, and the chief variation in the method now employed, we shall pass on to the manner of proceeding with the work to be japanned; the first in order will be the—

Priming.—The priming is a composition of strong size and whiting. The size should be of a consistency between the common double size and the glue, and mixed with as much whiting as will give it a good body, so as to hide the surface of whatever it is laid upon. But when the work is of a more particular kind, it is better to employ the glover's or parchment size, instead of the common, and if about a fourth of isinglass be added it will be still better, and if not laid on too thick, will be much less liable to peel or crack. The work should be prepared for this priming by being well cleaned, and brushed over with hot size, diluted with two-thirds of water, provided it be of common strength; the priming should be then laid on with a brush as

evenly as possible, and left to dry. If the surface be tolerably even on which the priming is used, two coats of it laid on in this manner will be sufficient; but if on trial with a wet rag or sponge it will not receive a proper water polish, on account of any inequalities not sufficiently filled up, one or more coats must be given it. Previous to the last coat being laid on, the work must be smoothed by rubbing it with the Dutch rushes, or fine glass paper. When the last coat is dry, the water polish should be given, by passing over every part of it with a fine rag or sponge moistened, till the whole appear perfectly plain and even; the priming will then be completed, and the work ready to receive the japan ground, or colored varnish. But when wood or leather is to be japanned, the latter being first securely stretched on a frame or board, and no priming is used, the best preparation is to lay on two or three coats of coarse varnish, prepared in the following manner:—Take of rectified spirits of wine one pint, and of coarse seed-lac and resin, each two ounces. Dissolve the seed-lac and resin in the spirit, and then strain off the varnish. This varnish, like all other formed of spirits of wine, must be laid on in a warm place, and all dampness should be avoided; for either cold or moisture chills it, and thus prevents its taking proper hold of the substance on which it is laid. When the work is so prepared, or by the priming with the composition of size and whiting before described, the proper japan ground must be laid on.

(To be continued.)

HINTS ON USING THE MICROSCOPE.

(Resumed from page 200, and concluded.)

The play of light and shade will also serve to enable us to distinguish the forms of objects. The surfaces which appear black are those which deflect the light out of the focus of the microscope; and the bright surfaces are those which transmit to the eye the light which traverses them. Now, as all the rays are reflected by the mirror below, it is not difficult to determine by the laws of refraction the form which is capable of producing the deviations observed in the microscope. It is by this means that we ascertain the crystalline forms of salts, and are enabled to prove that those pores which modern observers have represented on the surface of vegetable membranes are, in fact, globules projecting from their surface: for, if they were pores, they would appear black when plunged into water, in consequence of the air which they would retain; but the contrary is the case. We must take care, in determining the form of a body, to view it on all sides, which may be done either by turning it with the point of a needle, or by placing it in a volatile liquid, which, by its evaporation, is kept in continual agitation. A small quantity of alcohol added to the water on the object-holder is sufficient thus to set in motion the heaviest objects submitted to examination.

In determining the color of bodies observed by the microscope, we must take account of the decomposition of the rays of light both by the lenses if they be not achromatic, and by the substance itself; for there are some objects, such as certain animal oily matters, which only allow the transmission of the less refrangible rays, especially the yellow. In order to ascertain whether this color be natural to the object or not, we must observe it by reflected light on an opaque ground. The decomposition of the rays is so great with the solar microscope, even when achromatic, that the edges of the image are always colored blue and yellow. The same thing happens when, with the ordinary microscope, we use the direct light of the sun to illuminate the object.

The form and relative density of the substance being thus ascertained, we proceed to study the effects of chemical reagents on it.

We shall first endeavour to obtain, by processes on the large scale, the substance to be examined, in the purest state possible. Thus the problem will be reduced to its simplest expression. If we cannot attain this object, we must endeavour to ascertain, by the ordinary means, the nature of the elements of the mixture, which will furnish some data to our subsequent microscopic observations.

Afterwards we must ascertain the results of the action of the reagents on the substance under observation, both in the humid and in the dry way; we must delineate the new forms which result from this action, and measure the angles of the crystalline forms, whose nature we shall afterwards have to ascertain by other reagents and tests. When the results furnished by these trials appear to possess some importance, we must try to reproduce similar results *ab initio*, by combining together the elements which we believe to be present. If these two series of experiments do not give results which coincide, we must endeavour to discover whether the difference may not proceed from the disturbing effect of some foreign substance mixed with the one under observation; and for this purpose we must prepare mixtures, of each of the elements which we have by the previous trials detected in the body examined, with each of the others, and with every combination of them.

The action of an elevated temperature is most powerful as a means of distinguishing organic from inorganic substances. For the purpose of submitting bodies to the action of fire, we use plates of glass, very thin, and therefore less liable to crack. They must be brought near the fire, and withdrawn from it with great caution, that they may not be too suddenly heated and cooled. The form of the object and its chemical relations must be determined both before and after it has been subjected to heat.

In studying the motions which the bodies observed often exhibit, account must be taken of the motions impressed on the liquid in which they are immersed, either by the agitation of the air, or by evaporation, or by the observer's hands, or by being imbibed by the body; for a body which absorbs the liquid in which it floats must, of course, be moved, in the same way as a boat having on board a horizontal sucking-pump in action.

We may also ascertain with the microscope the relative density of a body and a liquid, by throwing the body into it. It will either remain at the bottom, or rise again to the surface; and, in this latter case, it will either be transparent or strongly shaded. This last character is a proof that it has not been in any way wetted by the liquid; that, consequently, it scarcely touches the liquid, except at one point; and that it is observed in the air just as if it were laid directly on the glass-plate. But it must be observed, that certain bodies which attract the liquid in which they are placed, and which are heavier

than it, yet remain for some time on its surface, because they imbibe it slowly: by and by, however, they sink to the bottom. We must not, therefore, be hasty in concluding; and it may be well to accelerate the wetting of the body, by agitating the liquid with the point of a needle or wire.

In short, it is the business of the observer to attend to every circumstance and investigate its cause—to call in the aid of analogy—to follow up the line marked out by experiment—to reproduce on the large as well as on the small scale the reaction which he has witnessed under the microscope—to describe and delineate every thing which he has had an opportunity of observing, even if he be not as yet able to find out the theory of the phenomena; and, finally, not to adopt any conclusion until after a decisive test has impressed on it all the character of certainty. Thus far regarding the work of the mind, that is, the method of proceeding.

With regard to manual operations, manipulations, and modes of observation, practice and habit will teach much more than the most detailed rules. With the compound microscope, it is necessary in dissection and other manipulations to become familiar with the inversion of the images, and to accustom the left hand to touch the parts which the eye sees towards the right, and *vice versa.* Although the employment of the compound microscope is not indispensable, it must be acknowledged, at the same time, that, for dissection and manipulation, it possesses a great superiority over the simple microscope, from the distance which intervenes between the eye of the observer and the object-holder, which serves as his laboratory. In fact, the hands have the same freedom in working with this instrument as in experiments on the large scale.

Microscopic observations fatigue the eye, and are apt to hurt the chest. The eye becomes at last accustomed to the continued exertion; but, in consequence of the impatience of the observer suspending or retarding the respiration, which is otherwise constrained from the position of the body, considerable uneasiness, and even serious evil, may be produced by excess in this kind of labor. The observer ought, therefore, to avoid a fatiguing position, by placing the microscope at such a height that he may not be obliged to bend his body. A table furnished with a rack is well adapted for this work. The microscope may also be so placed that the eye may, at the same time, see distinctly the magnified image and the trace which the observer is making of it on paper; we say the trace; for it will at intervals happen that, by a happy illusion, the microscopic image will seem for a moment to be laid over the paper so that its outlines can be traced as exactly by a pencil, as in drawing on a plate of glass placed over the object.

With the help of an achromatic microscope, objects may be observed and delineated as well by the light of a lamp as by day-light.

CHEMICAL TESTS.

(Resumed from page 189.)

To detect Alum in Red Wine.—Add to the wine a sufficient quantity of a strong solution of chlorine in water, until it is changed to a yellow color; let the precipitate, (composed of the chlorine and the vegeto-animal matter contained in the wine,) which immediately forms, become settled, then filter the liquor, and evaporate it to one-fourth of its volume: it will, now, in consequence of the presence of the alum, have an astringent sweetish taste, and will furnish a *white* precipitate on the addition of nitrate of barytes, which is insoluble in water and in nitric acid. It will give a *yellowish-white* precipitate with pure potass, that is soluble on the addition of an excess of the potass; and a precipitate, of the same color, with the sub-carbonate of soda, which is decomposed by the action of heat, into carbonic acid gas and alum, substances easily to be recognised by their characteristics.

Tests for the purity of the Acetous and Acetic Acids.—These acids, from distillation in leaden and copper vessels, very often contain acetates of lead, and copper in solution; and they are often wilfully adulterated by sulphuric acid to increase their acidity. To detect these, pour into three wine-glasses some distilled vinegar, (acetous acid,) or one dram of the acetic acid, diluted with three drams of distilled water. Into one of these pour some Harrowgate water, (which contains sulphuretted hydrogen.) If lead be present, a very sensible black precipitate will fall down. Into the second glass, pour a solution of pure ammonia. If copper be present, the whole will immediately become light blue. Into the third pour a few drops of the solution of muriate of barytes; if the acid contains sulphuric acid, the liquid in the glass will instantly become quite milky, from a precipitation of sulphate of barytes, which is a very insoluble salt.

Tests to determine the purity of Sulphuric or Nitric Ether.—If any ether will redden litmus paper, immersed in it, it is a proof that it contains superabundant acid, such as the sulphuric, acetic, or nitric; consequently the ether cannot be pure. A superabundant portion of sulphuric acid in sulphuric ether may be discovered by pouring a few drops of the solution of muriate of barytes into a dram of the ether: if this be the case, a white precipitate will take place, which is the sulphate of barytes.

Test to discover the purity of Nitrate of Silver.—To a solution of nitrate of silver add a solution of the muriate of soda; here decomposition taking place on both sides, nitrate of soda and muriate of silver will be formed. The latter of these will fall down in the state of a flocculent white precipitate.

But as this valuable salt is sometimes adulterated by copper, it is proper to ascertain its purity, by pouring into a solution of it, in another glass, a solution of pure ammonia. If copper be present, it will be indicated by a light blue precipitate which will pervade the fluid.

Ammoniacal and Muriatic Acid Gases, Tests for each other.—If a bottle containing muriatic acid, and another containing water of ammonia be brought together, with their mouths open, a dense smoke will be seen to hover round them: this is muriate of ammonia, which is a solid substance, but formed by the union of two invisible vapours. If the bottles are opened apart, no vapour will be seen. When two jars, filled with these gases, are brought in contact, the effect is striking; but it is more so when ammoniacal gas is let up from the beak of a retort through mercury into a jar half filled with muriatic acid gas. Here, the muriate of ammonia will be seen deposited on the sides of the jar, in the form of beautiful needle-like crystals. From these experiments it is evident that ammonia, and muriatic acid-gas, are good tests to discover each others presence in liquids.

(To be continued.)

WILLIAMS'S TRANSFEROGRAPHY.

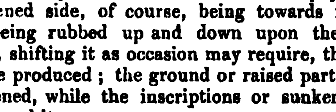
WILLIAMS'S TRANSFEROGRAPHY.

To the Editor.

My Dear Sir —I feel much pleasure in forwarding you a description of my method of copying inscriptions, and also specimens of the same. I have had some difficulty in finding such as would approach your size, for every copy is by necessity of exactly the same size as the original, and it is rather unusual to meet with an object whose dimensions are as small as you require, and at the same time whose subject is tolerably complete. I have, however, sent you a small portion of the Babylonian inscriptions in arrow-headed characters, on the celebrated stone in the Museum at the East India House, together with the figures and inscriptions on three sides of a small mutilated object in the possession of Dr. Lee, of Doctor's Commons—one or other of these may possibly suit your purpose. (We present to our readers a fac-simile of both. —Ed.) The mode of proceeding in order to make these copies may be thus described.

Provide a quantity of thin white paper, that called double-crown is the sort I use, and which I find the most convenient, as it has no glazing or stiffening, and is also sufficiently thin for the purpose. A sheet of this is to be spread evenly over the surface of the object to be copied, and firmly fixed by means of stiff paste applied to the corners or any other convenient part of the edge—the thickest kind of paste used by shoemakers, which may be obtained at any of the shops where their materials are purchased, is the best adapted for this purpose.

It is of the utmost importance that the paper should be securely fixed, as any slip after the commencement of the operation of copying will completely spoil the work. A piece of paper blackened on one side with a composition of black lead and soap, mixed with water to the consistency of stiff paste, and then by means of a spatula or broad knife, spread very evenly, and also as thinly as possible over the paper, is now to be applied by means of a piece of wood to the white paper, the blackened side, of course, being towards it, and this being rubbed up and down upon the white paper, shifting it as occasion may require, the copy will be produced; the ground or raised parts being blackened, while the inscriptions or sunken parts remain white paper.



A shows the shape of the piece of wood, it may be one inch wide and half an inch thick. B shows the blackened paper.

The distinctness and perfection of the copy will mainly depend upon the care taken in the operation, and also upon the condition of the object to be copied, for as every accidental defect in the face of the stone is also shown in the copy, it necessarily follows that the more perfect the object the more satisfactory will the copy be.

In this manner perfectly accurate copies of inscriptions may be produced in a very short space of time, without the slightest injury to the object itself, unless it should chance to be so much decomposed as to crumble beneath the gentle pressure required to transfer the black composition from one paper to the other, this however is very rarely the case, and I need scarcely add, that under such circumstances the stone ought not to be touched. I lately had occasion to make a copy of the rosetta stone, in the British Museum, which is the length of about three feet, contains three very closely inscribed inscriptions; one in hieroglyphics, one in the common characters of Egypt at that time, and the third in Greek; consisting altogether of 100 lines. This task was performed in one hour and a half, and I have no hesitation in affirming, that had the attempt been made to produce a perfect fac-simile by copying in the usual manner, it could not have been executed in less than a month. I have also copied the whole of the sarcophagus in Sir John Soane's museum, which is covered with very small characters, both within and without; this occupied me about 16 hours. I need scarcely inform you that my collection, which has almost exclusively been confined to Egyptian inscriptions, consists of copies of several hundred objects, including most of those in the British Museum, together with a number of others in different public and private collections. I have also an improvement upon this method, which under proper management and encouragement might be made of the highest importance to those to whom such things are valuable; it is by using a lithographic composition upon transfer paper, for producing the copies; under these circumstances they may immediately be transferred to the lithographic stone and printed, and thus an unlimited number of fac-similes of any given inscription may be produced. I also inclose you one of these copies. Trusting this account will be sufficiently explicit, and wishing you every success in your valuable and cheap periodical, believe me to remain, very truly your's, JOHN WILLIAMS.

School House, Spitalfields.

[The above was written in answer to a letter, requesting the above information, and we beg to add our testimony of the extreme value of the invention, particularly to the antiquarian traveller. We have been favored, by the kindness of Mr. Williams, with a sight of the whole of his extensive and valuable collection of inscriptions, and cannot speak in sufficiently high terms of their perfection and accuracy.—Ed.]

JAPANNING.

(Resumed from page 223.)

Japan Grounds.—The proper japan grounds are either such as are formed by the varnish and color, where the whole is to remain of one simple color, or by the varnish with or without color, on which some painting or other decoration is afterwards to be laid. This ground is best formed of shell-lac varnish, and the color desired; except in the case of white, which requires a peculiar treatment, as we shall presently explain, or when great brightness is required, in which case also other means must be pursued. The following is the composition and manner of preparing the shell-lac varnish:—Take of the best shell-lac, five ounces; break it into a very coarse powder, and put it into a bottle that will hold about three pints or two quarts; add to it one quart of rectified spirits of wine, and place the bottle in a gentle heat, where it must continue two or three days, but should be frequently well shaken.

The gum will then be dissolved, and the solution should be filtered through a flannel bag; and when what will pass through freely is come off, it should be put into a proper sized bottle, and kept carefully stopped up for use. The bag may also then be pressed with the hand till the remainder of the fluid be forced out; which, if it be tolerably clear, may be employed for coarser purposes, or kept to be added to the next quantity that shall be made. Any pigments whatever may be used with the shell-lac varnish, which will give the tint of the ground desired, and they may be mixed together to form any compound colors; but, with respect to such as require peculiar methods for producing them of the first degree of brightness, we shall particularize them below. They should all be ground very smooth in spirits of turpentine, and then mixed with the varnish. It should be spread over the work very carefully and even with a camel-hair brush. As metals never require the priming of size and whiting, the japan ground may be applied immediately to them, without any other preparation than cleaning, except in the instances referred to below.

White Japan Grounds.—The forming a ground perfectly white, and of the first degree of hardness, has not yet been attained in the art of japanning, as there are no substances which can be dissolved, so as to form a very hard varnish, but what have too much color not to deprave the whiteness. The nearest approach, however, to a perfect white varnish already known, is made by the following composition:—Take flake-white, or white-lead, washed and ground up with the sixth of its weight of starch, and then dried; temper it properly for spreading with the mastic varnish prepared in the following manner:—Take five ounces of mastic in powder, and put it into a proper bottle, with a pound of spirit of turpentine; let them boil in a gentle heat till the mastic be dissolved, and if there appear to be any foulness, strain off the solution through a flannel. Lay these on the body to be japanned, prepared either with or without the priming, in the manner as above directed, and then varnish over it with five or six coats of the following varnish:—Provide any quantity of the best seed-lac, and pick out of it all the clearest and whitest grains; take of this seed-lac two ounces, and of gum animi three ounces, and dissolve them, being previously reduced to a coarse powder, in about a quart of spirit of wine, and strain off the clear varnish. The seed-lac will give a slight tinge to this composition; but it cannot be omitted where the varnish is wanted to be hard, though where a softer will answer the end, the proportion may be diminished, and a little crude turpentine added to to the gum animi, to take off the brittleness. A very good varnish entirely free from brittleness may be formed by dissolving gum animi in old nut or poppy oil, which must be made to boil gently when the gum is put into it. The ground of white may be laid on in this varnish, and then a coat or two of it may be put over the ground, but it must be well diluted with oil of turpentine before it is used. This, however, is a long time in drying, and is more liable to injury than the other, from its tenderness.

Blue Japan Grounds may be formed of bright Prussian blue, or of smalt. The color may be mixed with the shell-lac varnish, as before directed, but as the shell-lac will somewhat injure the color by giving it a yellow tinge, where a bright blue is required, the method before directed in the case of white grounds must be pursued.

For a Scarlet Japan Ground, vermilion may be used; but its effect is much improved by glazing it over with carmine or fine lake. If, however, the highest degree of brightness be required, the white varnish must be used.

For Bright Yellow Grounds, king's yellow may be used, and the effect will be heightened by dissolving powdered turmeric root in the spirit of wine, of which the upper or polishing coat is made, which spirit of wine must be strained from off the dregs, before the seed-lac be added to it to form the varnish, The seed-lac varnish is not equally injurious here, as in the case of some other colors, because being tinged with a reddish yellow, it is little more than an addition to the force of the colors.

Green Grounds may be produced by mixing the Prussian blue, or distilled verdigris, with king's yellow, and the effect will be rendered extremely brilliant, by laying them on a ground of gold-leaf. They may any of them be used successfully with good seed-lac varnish, for the reasons before given.

Orange Colored Grounds may be formed by mixing vermilion, or red lead, with king's yellow or orange lake; or red orpiment will make a brighter orange ground than can be produced by any mixture.

Purple Grounds may be produced by the mixture of lake or vermilion with Prussian blue. They may be treated as the rest with respect to the varnish.

Black Grounds may be formed by either ivory-black or lamp-black; but the former is preferable. These may be always laid on with the shell-lac varnish. and have their upper or polishing coats of common seed-lac varnish.

Common Black Japan Grounds on Metal, by means of heat, are thus performed:—The piece of work to be japanned must be painted over with drying oil, and when it is moderately dry, must be put into a stove of such heat as will change the oil black without burning it. The stove should not be too hot when the work is put into it, nor the heat increased too fast, either of which errors would make it blister; but the slower the heat is augmented, and the longer it is continued, provided it be restrained within a due degree, the harder will be the coat of japan. This kind of japan requires no polish, having received, when properly managed, a sufficient one from the heat.

The Tortoise-shell Ground, produced by heat, is not less valuable for its great hardness, and bearing to be made hotter than boiling water without damage, than for its beautiful appearance. It is to be made by means of a varnish prepared in the following manner:—Take one glass of linseed oil, and half a pound of amber; boil them together till the oil becomes very brown and thick; strain it then through a coarse cloth, and set it again to boil, in which state it must be continued till it acquire a consistence resembling that of pitch; it will then be fit for use. Having thus prepared the varnish, clean well the substance which is to be japanned; then lay vermilion, tempered with shell-lac varnish, or with drying oil very thinly diluted with oil of turpentine, on the places intended to imitate the more transparent parts of tortoise-shell. When the vermilion is dry, brush the whole over with black varnish, tempered to a due consistence with the oil of turpentine. When set and firm, put the work into a stove where it may undergo a very strong heat, which must be continued a considerable time: if even three weeks or a month it will be better. This ground may be decorated with paint-

ing and gilding in the same manner as any other varnished surface, which had best be done after the ground has been hardened; but it is well to give a second annealing with a more gentle heat after it is finished. A very good black japan may be made by mixing a little japan gold size with ivory or lamp-black; this will bear a good gloss without requiring to be varnished afterwards.

(To be continued.)

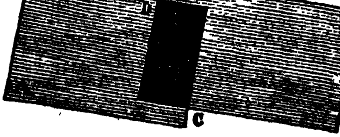
ASCERTAINING THE INTENSITY OF LIGHT.

As the different inflammable gases vary in the proportions of light which they respectively yield by combustion, many experiments have been made with the view of ascertaining the precise quantity that each is capable of affording, in order to determine their comparative value for the purposes of illumination. Though in some instances the results may have differed, it seems to be generally admitted that the luminous quality of the gas chiefly depends upon the portion of carbon which is held in solution by the hydrogen, and also upon the quantity of oxygen which each may require for its perfect combustion, according to its volume. For instance, as a cubic foot of oil gas contains in its composition a greater portion of carbon in a state of combination with hydrogen, than a cubic foot of coal gas, the former requires a greater proportion of oxygen for its complete combustion than the latter, and therefore produces a greater quantity of light. Besides, the light of the oil gas being not only whiter, but more brilliant, this is attributed to the larger portion of carbon which it contains, as well as the greater supply of oxygen combining with it in order to effect its perfect combustion to produce its highly resplendent flame.

It is an important object to have some criterion for judging of the proportionate intensity of the light which either candles, lamps, or gases produce, that their relative illuminating power may be estimated by a comparison of their luminous qualities. Different methods have been devised to ascertain this point, but the one which has been found best adapted for the purpose, is that of judging by the blackness or faintness of the shadows produced, when an opaque substance is placed between the different illuminating bodies and a white paper or wall. This mode of estimating the intensity of light has the advantage of being easily practised and understood, and will be found fully adequate to prove the great superiority of the gas light both as regards the *quantity* of its light and the *economy* of its use. Moreover, it is so near an approach to correctness, that it may be deemed satisfactory for all the common purposes of estimating light; and, indeed, it is the only mode by which we can judge of many of the properties of the objects cognizable by the organs of sight.

But perhaps the following explanation will farther elucidate the principle on which this method is founded. It is well known that the light emanating from any luminous body always moves in straight lines, and diverges, or in other words, spreads itself in every direction; and it is also known that the *intensity* of the light *decreases* in proportion as the *distance increases* from the point whence it proceeds. For example: if in a dark night a lighted candle be placed on an elevated spot, the rays of light issuing from it will be diffused in every direction for half a mile round it; but although the rays from so small a flame will fill the space of a mile in diameter, yet in proportion to their distance from the candle, they are perceived to be weaker or stronger. Hence has been deduced the law for estimating the quantity of light in any given circumstances, which is, that the *intensity* or degree of light *decreases* as the *square* of the *distance* from the luminous body *increases*. For instance: the light emanating from any luminous body, at the distance of 1, 2, 3, 4 feet or yards, will be diminished in proportion to the squares of those numbers, or as 1, 4, 9, 16: thus at the distance of two yards, the light will be *four* times less than at *one* yard; at *three* yards it will decrease so as to be *nine* times less; at *four* yards it will be *sixteen* times less; and so on in the same ratio. It is upon this property of light that the comparison has been made between the gases and the various kinds of lamps and candles, to ascertain their relative illuminating power. The following very clear and happy illustration of the practical application of this principle is given by Mr. Nicholson in his Journal:—

"The method of measuring the comparative intensities of light, is one of the first requisites of an inquiry concerning the art of illumination. Two methods of considerable accuracy are described in the Traité d'Optique of Bougeur, of which an abridged account is given by Dr. Priestley. The first of these two methods has been used by others since that time, and probably before, from its very obvious nature, but particularly by Count Rumford, who has given a description and drawings of an instrument called a Photometer, in the Philosophical Transactions for 1794. The principle it is to be grounded upon is this: that if two lights shine upon the same surface at equal obliquities, and an opaque body be interposed, the two shadows it will produce must differ in blackness or intensity in the same degree. For the shadows formed by intercepting the greater light, will be illuminated by the smaller light only; and, reversely, the other shadow will be illuminated by the greater light: that is to say, in short, the stronger light will be attended with the deeper shadow. But it is easy, by removing the greater light to a greater distance, to render the illumination it produces at the common surface, equal to that afforded by the less. Experiments of this kind may be conveniently made by fastening a sheet of white paper against the wall of a room. Two lights or candles intended to be compared must then be placed so that the ray of light from each shall fall with nearly the same angle of incidence upon the middle of the paper. In this situation, if a book or other object be held to intercept part of the light which would have fallen on the paper, the two shadows may be made to appear as in the figure



where A represents the surface illuminated by one of the lights only; B, the surface illuminated by the other light; C, the perfect shadow from which both lights are excluded. It will easily be under-

stood, that the lights about D and E, near the angle F, will fall with equal incidences when the double shadow is made to occupy the middle of the paper, and consequently, if one or both of the lights be removed directly towards or from the paper, as the appearances may require, until the two shadows at E and D have the same intensity, the quantity of light emitted by each will be as the squares of the distances from the paper. By some experiments made in this way in the year 1785, I was satisfied that the degree of illumination could be ascertained to the eightieth or ninetieth part of the whole."

But in making a comparison between different kinds of light, its color is a circumstance which requires to be noticed; for it will be perceived, that the difference in the intensity, and of course the quantity of light, varies materially according to the color of the flame. Thus the most brilliant light will be found to proceed from a flame which approaches the nearest to a pure *white*, but that its lustre gradually diminishes in proportion as it deviates from that, and approaches to a *brown*. Sometimes the difference in color may also occasion a little difficulty or mistake in estimating the quantity of light by the appearance of the respective shadows; but by changing the position of one of the lights, and trying the effect of placing it a little on each side of that point where the observer may suppose the shadows to be alike in depth, he will be able to ascertain the proper distance, and of course obviate any error which might otherwise occur.

From the different kinds of burners not only varying in their color, but also in the relative quantities of their light, in order to compare the quantity of light which they may respectively yield, more than one observation becomes necessary. For instance, the light of a candle must, in the first place, be compared with that of a gas jet; and then the light afforded by a gas jet with that of an Argand lamp: and in comparing the light produced by the burning of different gases, the coal-gas jet must be compared with an oil-gas jet; and these again with coal and oil gas burners of different constructions and dimensions. Thus, by a comparison of the effect of different flames arising from their various sizes, color, &c., a tolerably correct estimate may be formed of their relative illuminating power; and from the simplicity and facility of the operation, it requires but little practice to render this manner of experimenting familiar.

SEALING-WAX.

The Hindus from time immemorial have possessed the resin lac, and were long accustomed to use it for sealing manuscripts before it was known in Europe. It was first imported from the East into Venice, and then into Spain; in which country sealing-wax became the object of a considerable commerce, under the name of Spanish wax.

If shellac be compounded into sealing-wax, immediately after it has been separated by fusion from the palest qualities of stick or seed lac, it then forms a better and less brittle article, than when the shell-lac is fused a second time. Hence sealing-wax, rightly prepared in the East Indies, deserves a preference over what can be made in other countries, where the lac is not indigenous. Shellac can be restored in some degree, however, to a plastic and tenacious state by melting it with a very small portion of turpentine. The palest shellac is to be selected for bright-colored sealing-wax, the dark kind being reserved for black.

The following prescription may be followed for making red sealing-wax:—Take 4 ounces of shell-lac, 1 ounce of Venice turpentine, (some say 1¼ ounces,) and 3 ounces of vermilion. Melt the lac in a copper pan suspended over a clear charcoal fire, then pour the turpentine slowly into it, and soon afterwards add the vermilion, stirring briskly all the time of the mixture with a rod in either hand. In forming the round sticks of sealing-wax, a certain portion of the mass should be weighed while it is ductile, divided into the desired number of pieces, and then rolled out upon a warm marble slab, by means of a smooth wooden block, like that used by apothecaries for rolling a mass of pills. The oval sticks of sealing-wax are cast in moulds, with the above compound in a state of fusion. The marks of the lines of junction of the mould-box may be afterwards removed by holding the sticks over a clear fire, or passing them over a blue gas-flame. Marbled sealing-wax is made by mixing two, three, or more colored kinds of it, while they are in a semi-fluid state. From the viscidity of the several masses, their incorporation is left incomplete, so as to produce the appearance of marbling. Gold sealing-wax is made simply by stirring gold-colored mica spangles into the musk, or other perfume. If 1 part of balsam of Peru be melted along with 99 parts of the sealing-wax composition, an agreeable fragrance will be exhaled in the act of sealing with it. Either lamp black or ivory black serves for the coloring matter of black wax. Sealing-wax is often adulterated with rosin, in which case it runs into thin drops at the flame of a candle.

FORMATION OF PEAT.

The generation of peat, when not completely under water, is confined to moist situations, where the temperature is low, and where vegetables may decompose without putrefying. It may consist of any of the numerous plants which are capable of growing in such *stations*; but a species of moss *(Sphagnum palustre)* constitutes a considerable part of the peat found in marshes of the north of Europe; this plant having the property of throwing up new shoots in its upper part, while its lower extremities are decaying. Reeds, rushes, and other aquatic plants may usually be traced in peat; and their organization is often so entire that there is no difficulty in discriminating the distinct species.

Analysis of peat.—In general, says Sir H. Davy, one hundred parts of dry peat contain from sixty to ninety-nine parts of matter destructible by fire; and the residuum consists of earths usually of the same kind as the substratum of clay, marl, gravel, or rock, on which they are found, together with oxide of iron. "The peat of the chalk counties of England," observes the same writer, "contains much gypsum; but I have found very little in any specimens from Ireland or Scotland, and in general these peats contain very little saline matter." From the researches of Dr. MacCulloch, it appears that peat is intermediate between simple vegetable matter and lignite, the conversion of peat to lignite being gradual, and being brought about by the prolonged action of water.

Peat abundant in cold and humid climates.—Peat is sometimes formed on a declivity in mountainous regions, where there is much moisture; but in such situations it rarely, if ever, exceeds four feet in thickness. In bogs, and in low grounds into which alluvial peat is drifted, it is found forty feet thick, and upwards: but in such cases it generally owes one half of its volume to the water which it contains. It has seldom, if ever, been discovered within the tropics; and it rarely occurs in the valleys, even in the south of France and Spain. It abounds more and more, in proportion as we advance farther from the equator, and becomes not only more frequent but more inflammable in northern latitudes.

Extent of surface covered by peat.—There is a vast extent of surface in Europe covered with peat, which, in Ireland, is said to extend over a tenth of the whole island. One of the mosses on the Shannon is described by Dr. Boate to be fifty miles long, by two or three broad; and the great marsh of Montoire, near the mouth of the Loire, is mentioned, by Blavier, as being more than fifty leagues in circumference. It is a curious and well-ascertained fact, that many of these mosses of the north of Europe occupy the place of forests of pine and oak, which have, many of them, disappeared within the historical era. Such changes are brought about by the fall of trees and the stagnation of water, caused by their trunks and branches obstructing the free drainage of the atmospheric waters, and giving rise to a marsh. In a warm climate, such decayed timber would immediately be removed by insects, or by putrefaction; but, in the cold temperature now prevailing in our latitudes, many examples are recorded of marshes originating in this source. Thus, in Mar forest, in Aberdeenshire, large trunks of Scotch fir, which had fallen from age and decay, were soon immured in peat, formed partly out of their perishing leaves and branches, and in part from the growth of other plants. We also learn, that the overthrow of a forest by a storm, about the middle of the seventeenth century, gave rise to a peat moss near Lochbroom, in Ross-shire, where, in less than half a century after the fall of the trees, the inhabitants dug peat. Dr. Walker mentions a similar change, when, in the year 1756, the whole wood of Drumlanrig in Dumfries-shire was overset by the wind. Such events explain the occurrence, both in Britain and on the Continent, of mosses where the trees are all broken within two or three feet of the original surface, and where their trunks all lie in the same direction.

Nothing is more common than the occurrence of buried trees at the bottom of the Irish peat-mosses, as also in most of those of England, France, and Holland; and they have been so often observed with parts of their trunks standing erect, and with their roots fixed to the sub-soil, that no doubt can be entertained of their having generally grown on the spot. They consist, for the most part, of the fir, the oak, and the birch: where the sub-soil is clay, the remains of oak are the most abundant; where sand is the substratum, fir prevails. In the marsh of Curragh, in the Isle of Man, vast trees are discovered standing firm on their roots, though at the depth of eighteen or twenty feet below the surface. Some naturalists have desired to refer the imbedding of timber in peat-mosses to aqueous transportation, since rivers are well known to float wood into lakes; but the facts above mentioned show that, in numerous instances, such an hypothesis is inadmissable. It has, moreover, been observed, that in Scotland, as also in many parts of the Continent, the largest trees are found in those peat-mosses which lie in the least elevated regions, and that the trees are proportionally smaller in those which lie at higher levels; from which fact De Luc and Walker have both inferred, that the trees grew on the spot, for they would naturally attain a greater size in lower and warmer levels. The leaves also, and fruits of each species, are continually found immersed in the moss along with the parent trees; as, for example, the leaves and acorns of the oak, the cones and leaves of the fir, and the nuts of the hazel.

Recent origin of some peat-mosses.—In Hatfield moss, which appears clearly to have been a forest eighteen hundred years ago, fir-trees have been found ninety feet long, and sold for masts and keels of ships; oaks have also been discovered there above one hundred feet long. The dimensions of an oak from this moss are given in the Philosophical Transactions, No. 275, which must have been larger than any tree now existing in the British dominions.

In the same moss of Hatfield, as well as in that of Kincardine, and several others, Roman roads have been found covered to the depth of eight feet by peat. British and French mosses, are also Roman; so that a considerable portion of the European peat-bogs are evidently not more ancient than the age of Julius Cæsar. Nor can any vestiges of the ancient forests described by that general, along the line of the great Roman way in Britain, be discovered, except in the ruined trunks of trees in peat.

De Luc ascertained that the very site of the aboriginal forests of Hircinia, Semana, Ardennes, and several others, are now occupied by mosses and fens; and a great part of these changes have, with much probability, been attributed to the strict orders given by Severus, and other emperors, to destroy all the wood in the conquered provinces. Several of the British forests, however, which are now mosses, were cut at different periods, by order of the English parliament, because they harboured wolves or outlaws. Thus the Welsh woods were cut and burnt, in the reign of Edward I.; as were many of those in Ireland, by Henry II., to prevent the natives from harbouring in them, and harrassing his troops.

It is curious to reflect that considerable tracts have, by these accidents, been permanently sterilized, and that, during a period when civilization has been making great progress, large areas in Europe have, by human agency, been rendered less capable of administering to the wants of man. Rennie observes, with truth, that in those regions alone which the Roman eagle never reached—in the remote circles of the German empire, in Poland and Prussia, and still more in Norway, Sweden, and the vast empire of Russia—can we see what Europe was before it yielded to the power of Rome. Desolation now reigns where stately forests of pine and oak once flourished, such as might now have supplied all the navies of Europe with timber.

THE HOUR-GLASS.

In olden time, long ere the art of clock-making was discovered, our ancestors marked the fleeting hours by the flowing of sand in a glass. This contrivance was called the hour-glass, and it is still

very generally to be found upon the table of the public lecturer, or the private teacher, in the laboratory of the philosopher, or in the cottage of the peasant. It is a far more accurate measurer of time than is usually imagined, and, therefore, perhaps a short account of the theory of its action may be acceptable.

The investigation was undertaken a few years since by M. Bournand: his experiments are exceedingly curious, and merit to be more generally known. A few only of the most remarkable, and easy of performance, are detailed in the following notice.

The first remarkable fact regarding the hour-glass is, that the flow of its inclosed sand is perfectly equable, whatever may be the quantity contained in the glass, as any period of its flowing: or, in other words, that it runs no faster when the upper cone is quite full, than when it is nearly empty. This is contrary to what we might expect, for it would be natural enough to conclude, that when full of sand, the lowest particles would sustain a greater pressure from the incumbent mass, and, therefore, be more swiftly urged through the aperture, than when only a quarter full, and near the close of the hour.

The fact that the flow is equable, at any period, may be proved by a very simple experiment.

Provide a quantity of what is called silver-sand, (well known for domestic use,) dry it upon a hot stove-plate, or in an iron ladle over the fire; then sift it through a tolerably fine sieve, carefully removing all lumps of clay or stone, which are frequently found in it. Next, take a tube of any material, length, or diameter, closed at one extremity, and in the bottom make a small aperture, say the eighth of an inch, place the finger over this, or stop it lightly with a small plug, and then fill up the tube with the sifted sand.

Hold the tube steadily, or affix it to a wall, or a frame, at any convenient height from a table, and then removing the finger, or plug, permit the sand to flow in any measure, for any given time—supposing into a common graduated glass measure, for a quarter of a minute. A certain quantity is thus obtained, which must be noted. Now let the tube be only a half or a quarter full of sand, and begin to measure again, for a like time, the same quantity of sand will flow; and even if by means of a ruler or plug, the sand in the tube is violently pressed upon, the flow of the sand from the aperture will not, in the least degree, be accelerated, provided the tube is kept steady, and the experimental comparisons all accurately and fairly made. Now all this admits of a simple and satisfactory explanation. Sand, if allowed to fall quietly upon any surface, will form itself in a conical heap, having an angle of about 30°; this is seen in the lower cone of the hour-glass, or can be shown by letting the sand fall from the aperture of the tube just mentioned. Whenever a load of dry sand is thrown from a cart or barrow, or sifted through a screen, by the builder in making mortar, it forms a like conical heap, having an angle of 30° or 35°. Now, then, observe the application of this fact of every day occurrence; it will show how intimately "things familiar" are connected with practical science.

As sand thus falls at a determinate angle, it is easy to imagine that when poured into the tube, it must fill it with a succession of conical heaps, and that all the weight which the bottom of the tube sustains, is only that of the heap which first falls upon it, and that the succeeding heaps are thus prevented from exerting any perpendicular pressure upon the bottom, but that they only exert a lateral pressure against the walls of the tube.

When pressure is applied to the top of the sand, it is only transmitted laterally, and that to a very little extent; consequently the lowest heap of sand enjoys its flow uninfluenced by the strata or pressure above it. This is the reason why the hour-glass flows with such regularity; and that any given base sustains no weight of sand but that of the first heap which falls upon it, and is in immediate contact with it, may be proved by taking a tube, about an inch diameter, open at both ends, wetting with the lips the edges of a small piece of tissue-paper, and applying this to one end of the tube, so as to form a bottom held on by a very slight adhesion. Fill this tube carefully with any weight of sand, and the paper will not be forced away, not even if, with a round ruler or rod, great pressure is applied to the top surface of the sand. All the weight of sand that the tissue-paper supports is the little heap which first falls upon it.

If the experiment is made upon a larger scale, with tubes three or four inches in diameter, and five or six feet long, it is better to paste the paper round the bottom, because the first heap in such case would be of considerable weight; but if the paper is strong enough to resist *it*, forty or fifty pounds of sand may be poured into the tube, and all lifted from the ground together, without the slightest fear of the paper being forced away.

The experiment admits of another modification. Take the tube open at both ends, and place one of them in contact with the bottom of a small cup floating upon water, then fill up the tube with sand; none of it will run out into the cup; and that there is no perpendicular pressure is evident from the cup still continuing to float; it sustains no weight save that of the first heap,—the hand of the operator sustains the weight of all the rest of the sand. Draw away the tube, the sand then rushes into the cup in obedience to the law of gravitation, and its weight causes the cup to sink.

From such experiments it may be concluded that it must be extremely difficult to *thrust* sand out of a tube, by means of a fitting plug or piston; and this upon trial is found to be the case. Fit a piston to a tube, (exactly like a school-boy's pop-gun,) pour some sand in, and try with the utmost strength of arm to push out the sand. It will be found impossible to effect this; rather than the sand should be propelled, the tube will burst *laterally*.

Directions are often given by naturalists for shooting birds with a charge of fine sand, so that their plumage may not suffer the damage which is usually occasioned by an ordinary charge of small shot. This proceeding ought to be made with considerable caution, for it must be evident, from the last experiment, that a charge of sand would resist the expansive force of gunpowder, and violently strain the barrel, perhaps burst it; to say nothing of goring, and spoiling its polished interior by the rapid friction of the sand; and, supposing it in very small quantity, and successfully propelled, it is certainly rather a hazardous experiment. To prove how a small column of sand will resist the expansive force of a large charge of gunpowder, it will be sufficient to instance the method adopted by engineers for blasting rocks.

A hole is drilled in the rock, of the requisite depth, at the bottom of which the charge of powder is placed; a long match, or reed, filled with powder,

is then put down, and around this sand is merely *poured in*, so as to fill the hole; a train is laid and fired, and presently the explosion takes place, rending away the mass of rock. The loose column of sand is not *blown out* of the hole leaving the rock unshaken, but it keeps its place, until it compels the solid rock to yield unto its singular power.

The discoverer of these facts, relating to the flow of sand in the hour-glass, makes the following observations.

"There is, perhaps, no other natural force on the earth which produces by itself a perfectly uniform movement, and which is not altered either by gravitation, or the friction, or resistance of the air; for the *height* has no influence, *friction* in place of being an obstacle is the *regulating* cause, and the resistance of the air within the column must be so feeble as to be altogether insensible as a disturbing force."

ON PEPSINE, THE DIGESTIVE PRINCIPLE.

BY M. WASMANN.

In a very long memoir, M. Schwann has shown that the gastric juice contains a peculiar principle which he called *Pepsine*, but he had not succeeded in obtaining it in a state of purity. M. Wasmann has been able to isolate this principle, which, he says, resides in the grumous matter that fills the internal cells of the glandular membrane of the stomach.

M. W. prepared pepsine in the following manner:—He separated the glandular membrane from the stomach, without cutting it; he washed it and digested it in distilled water at a temperature of from 30 to 35°; at the end of a few hours, he decanted the liquid, and again washed the membrane in cold water, until it had a putrid odour. He filtered the combined liquids, and thus he obtained a transparent liquid, rather viscous and endowed with an eminent digestive power, when a little hydrochloric acid was added. In order to separate from it pepsine in the pure state, acetate of lead was added to it; the precipitate was washed and decomposed by a stream of sulphuretted hydrogen. The liquor separated from the new precipitate is fluid, colorless, and acid.

When, after having evaporated this liquor to a syrupy consistence, without raising the temperature above 35°, absolute alcohol is poured into it, an abundant flaky precipitate is produced in it, which, carefully dried, is presented under the form of a yellow gummy matter, which does not attract moisture;—this is M. Wasmann's pure pepsine.

This substance is soluble in water, which it renders acid, because it obstinately retains a certain quantity of acetic acid. The solution, even though it contains only 1.50000 of pepsine, dissolves, in from six to eight hours, slightly acidulated white of eggs; but it loses its digestive power when boiled, or when it is saturated by potassa. In the latter case, it deposits flakes which are insoluble in water, and which slowly dissolve in dilute acids, forming liquors of little power.

Pepsine is recognised in the precipitates determined in its solution by the dilute acids—which precipitates are redissolved in an excess of those acids. It is distinguished from albumen by the precipitates which acetic and hydrochloric acids occasion in its aqueous solution; and from caseum, because ferrocyanuret of potassium does not precipitate its acid solutions.

The concentrated aqueous solution of pepsine is rendered turbid by bi-chlorite of mercury and acetate of lead, which form precipitates soluble in the precipitating re-agent, and in acetic and hydrochloric acids. Sulphates of protoxide and deutoxide of iron, and chloride of tin, likewise precipitates formed by these metallic solutions possess digestive properties.

In burning, pepsine gives out the odour of burnt horn, and leaves a carbon difficult to incinerate, in which lime, soda, phosphoric acid, and a little iron, have been found.—*The Chemist.*

BLOW PIPE JET.

To the Editor.

Sir.—In answer to your correspondent J, I beg to state, from experiments tried by myself and a friend, three years ago, that the cooling properties of the tubes in a common cane are not sufficient to secure the operator from the *risk* of explosion of the mixed gases.

The experiments were tried with canes forced tightly into bored iron and brass tubes; with the former metal and a small cane we succeeded—but with a larger one in a brass tube, an explosion took place, almost instantaneously. I should, however, caution any one from attempting the experiment, as both my friend and I had a narrow escape of our lives during the investigations. I am, Sir, your's, most respectfully, JOHN JEROME.

Manchester, 25th September, 1840.

COATING METALLIC PLATES WITH IODINE FOR THE DAGUERREOTYPE.

To the Editor.

Sir.—I have found the following method the best for coating metallic plates with iodine. If you think it worth inserting it is at your service.

AMICUS.

Cheltenham, 12th Oct., 1840.

Procure a wooden box, an inch deep and about half-an-inch larger each way than the plate. Strew the bottom with iodine, cover it up, and let it remain twelve hours. Then remove the iodine, and place the plate, (which has previously been fixed in the metallic border, or band, on the slide as described by Daguerre,) with the face downward on the top of the box, and in two or three minutes it will be beautifully coated, every part being equally covered, and not having the iodine distributed in rings, as is often the case in Daguerre's plan.

To the Editor.

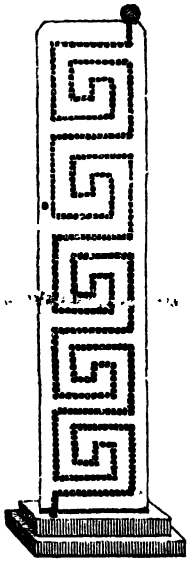
Sir.—I send you the following Compound, considered the very best for the preservation of stuffed birds and animals: it is used by the best stuffers in Yorkshire and Lancashire. G.

Pontefract, October 10th, 1840.

1 lb. of white arsenic.
2 lbs. ,, hellebore.
Mixed with spirits of turpentine.

Fig. 1

2



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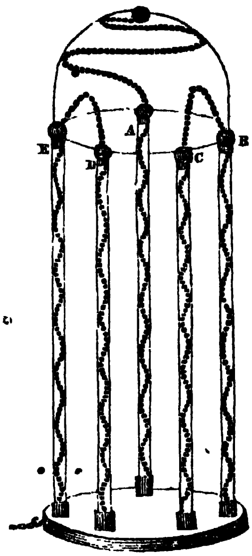

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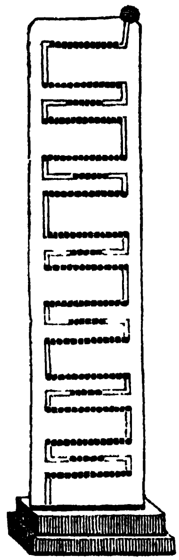

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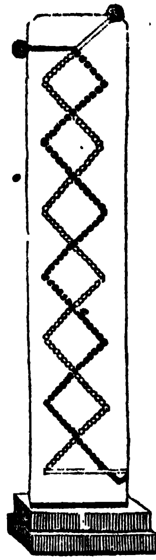
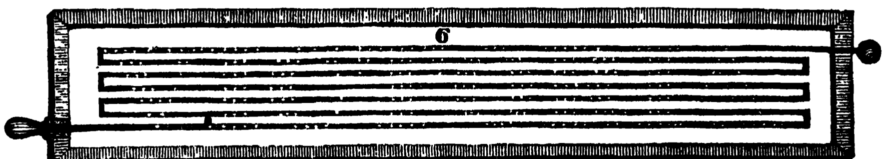
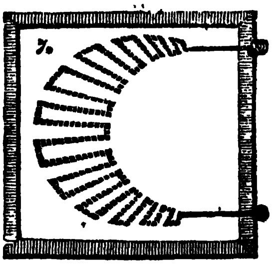
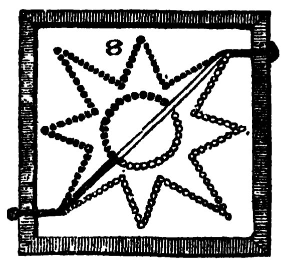


ELECTRICAL TRANSFERENCE AND DEVICES ON GLASS, &c.







ELECTRICAL TRANSFERENCE, AND DEVICES ON GLASS, &c.

ELECTRICAL transference, or the passage of the electrical fluid from one body to another, is the cause of some of the most beautiful experiments which this interesting science affords. It has been already observed, (No. XI., Vol. I.,) that the disturbed fluid in passing along conducting substances, such as metals and water, remains invisible, but when it is made to traverse the air, or any other electric or non-conductor, it becomes visible, and the appearance it then puts on is, as we have elsewhere seen, a stream of light, if issuing from a point into the air. If passing from a ball under the same circumstances, and not having any other ball or conductor, to give it a determined course, it will be apparent to us as passing off in fitful flashes, as are constantly seen to issue from the ball at the end of a prime conductor of the electrical machine.

If any round conductor be held in the hand, or if the closed hand itself be held at some distance from where these flashes issue, they will be seen to have a tendency towards it, and as the hand is made to approach to the prime conductor, so they will take a determinate form, color, and noise; first, when at the greatest striking distance, they will appear as faint, blue, and very zigzag sparks, like distant weak lightning; bringing the hand a little nearer, the sparks are more vivid, and consequently, whiter—they are thicker, well defined throughout their whole length, zigzag as before, and attended with a louder and quicker snap. At a less distance still, the brilliancy and snap is further increased, while the zigzag character, is by degrees lost, until at length the spark is so rapid as to be almost continuous, short, thick, and straight; as we see in that dangerous, though rarely witnessed kind of lightning, in which the heavens seem to burst, and pour down a short perpendicular stream of intense volume to the earth, killing and destroying every thing within many yards of its passage, as the Editor once had the misfortune to witness.

Such is the electric spark, and it may be advisable to remark, before proceeding further, how it is that the power of an electrical machine should be estimated. It is common to hear a person observe, relative to some machine, that it will give a spark so many inches long, without stating how such a spark is to be measured. If he take all the forks of the zigzag into account, undoubtedly it will much increase the measured distance; but this is not fair—still less is it to measure the spark upon the excited cylinder, for here the repulsion of the fluid from the overcharged conductor is assisted by the charged surface of the glass itself, and the attraction of the negatively-charged cushion, (as we have shown in page 107, Vol. I.) The true length of spark which a machine will give is to be measured by the distance between the terminating ball of the prime conductor, and a metallic ball held in the hand, when approaching them gradually to each other, and (the machine being in good action) a spark will pass between them. By this means of measurement, the real power of a machine may be known.

The color of the electric spark in passing through the air is always either white or blue, according to its intensity, yet when taken through other substances it varies according to their nature, as the following experiments will show:—

Ex. 41.—*Green and Red Sparks.*—Cover over the ball held in the hand a piece of silver leather, taking a spark with this it will appear of a green color, and over gilt leather a red color.—*Adams.*

Upon the principle that the electrical fluid becomes visible in the air only, are constructed all those beautiful instruments, known by the name of *luminous* devices, electrical words, and so on, the following will direct the reader not merely to their use, but it is hoped to their construction also, that those, who living at remote distances from manufacturing towns have not the opportunity, or lacking means have not the inclination to purchase, may yet not be deprived of the power and the means of amusement and instruction. As fundamental rules to be observed, let it be always remembered, that the sum of all the spaces on the glass, between one piece of tin-foil and another, must be much less than the length of the spark which the machine will give; in fact, altogether this aggregate space should be less than an inch. 2nd. The fluid always traverses from the prime conductor to the earth, and will, other circumstances being equal, always take the shortest course. 3rd. If the spaces in any two lines of dots be greater than the distance between that line and the next, the spark will fly across the lines, instead of going along both of them. 4th. The least possible space between one dot and another is sufficient, even if it be as fine as a hair. 5th. The lines must never cross each other, unless on different sides of the glass. 6th. When used they must be quite dry and warm.

Ex. 42.—*Shot Chain.*—Get some small shots, and string them at a *very* short distance from each other on a black silk thread. Hold one end of a piece of this chain, 2 or 3 inches in length, towards a charged conductor, and a vivid spark will pass along it.

Ex. 43.—*Spangle Chain.*—Sew some spangles on a black silk ribbon, very near together and in any desired form—a spark may be passed along this, and looks extremely beautiful.

Ex. 44.—*Spiral Tube.*—Fig. 1 represents this instrument. It consists of two glass tubes, placed one within the other. On the outside of the inner tube are fastened with *common paste* spangles of tin-foil, (punched out of the sheet of tin-foil with a small hollow punch;) the two ends of the tubes are wrapped round with tin-foil, and cemented each into a brass cap, taking care that the tin-foil at the ends, and the spangles and the brass caps are all in contact with each other. To use the spiral tube, hold one end in the hand and the other apply to the conductor, when a spark will pass along the whole length.

Ex. 45. — *Grecian Device.* — (Fig. 2.) This device of a Grecian fret border is made and used in the same manner, except that it is displayed on a flat piece of glass. The design is first drawn on paper, and the paper laid beneath the glass—paste along the glass, take up the spangles with the point of a knife, and lay them on the proper place. The foot of this is wood, either loaded with lead, or covered with tin-foil—in either case connected with the spangles.

Ex. 46.—*Set of Spirals and Dome.*—Fig. 3 is an experiment of extreme beauty. It consists of five or more spirals, with a dome of glass resting upon them at the top. The fluid runs along the curved line from the apex down A—along a strip of tin-foil pasted underneath to B; it ascends this tube, then down C, again underneath to D, and

again along the top to E, at the foot of which a chain connects it to the ground.

Ex. 47. Fig. 4.—This device is formed by pasting strips of tin-foil, according to the lines represented, and wherever the light is to be visible, cutting a line through with the point of a knife.

Note.—It is usually supposed to be necessary to make a cross cut at the luminous places, and to peck out the two small corners thus liberated. This, however, is quite unnecessary, merely drawing the knife across is quite sufficient. It may be advisable to state, that after the strips are pasted on, they should be suffered to dry, and the general surface carefully washed with warm water before cutting them across.

Fig. 5 represents an apparatus, similar to the last, except that one row of tin-foil is pasted on one side of the glass, and the other row on the opposite side, as is represented by the white and black dots—therefore the spark does not pass out at the foot near the top, its place of entrance and exit being represented by the two balls.

Fig. 7 is a crescent, the construction of which is exactly the same as that of Fig. 2.

Fig. 8 is a star, one half being on one side, the other half on the other side of the glass.

Fig. 6 is a word, formed in like manner to Fig. 4, though instead of pasting on the tin-foil in lines, it is better to paste a whole piece on the glass, and laying a flat ruler upon it, cut the various lines, and then tear off the tin-foil which covers the intervening places. By this means the lines may be preserved straighter than by the other method.

Devices of this kind may be further ornamented by colored varnishes spread over them, which will cause the spark to be varied in color, when seen on that side upon which the varnish was placed.

THE TIDE A TRUE BAROMETER.

In a memoir on the Tides of the Coasts of France M. Daussy states, that he has been induced to believe, from a great number of observations made at Brest, that when the weight of the atmosphere elevates the mercurial column of a barometer $\frac{1}{8}$ in., the mean level of the sea, is depressed fourteen times as much, or 1$\frac{3}{4}$ inches. The proportion of the specific gravity of mercury to sea-water being at 13·3 to 1, M. Daussy concludes that the mean level of the sea may be considered a true barometer, its changes always corresponding with those of the atmospheric pressure.

This remarkable result having been disputed by Mr. Lubbock,—as, in the observations made on the tides at London under his supervision, no indication of this connexion was detected,—M. Daussy felt obliged to ascertain, by experiments made at other points, if the fact observed at Brest was merely local, depending upon the immense basin, so nearly shut in, which spreads itself before the entrance of that port. He took advantage, for this purpose, of some tidal observations, which were ordered to be made by the Government in 1835, on different parts of the French coast, and principally of those at L'Orient, where the localities were favorable to the convenient observation of high and low water. He compared these with the barometric observations made at the same place during the months of August, September, October, November, and December, 1835. The result of this comparison confirmed his previous opinion, of the correspondence between the greatest heights of the mean level of the sea and the lowest of those of the barometer, except that the motion of the mean level is a little more marked at L'Orient than at Brest.

M. Daussy was further convinced that this effect was not owing, as some persons are disposed to believe, to the influence of the wind. "To determine this," he says, "I observed successively, during each kind of wind, regarding both its force and direction, and examined if the heights given by the mean level did not, in each series, follow an order analogous to that of the barometer; I was soon convinced, that the same law of variation did take place, and in all winds,—that is to say, that the wind remaining constant in direction and force, it was always found that the height of the mean level varied with the effect of atmospheric pressure." The number of these observations was small, and the conclusions drawn from them can apply to the port of L'Orient only: they are the following. First, That light winds have little influence on the height of the mean level, whatever may be their direction. Second, That fresh breezes have still less influence, Third, and lastly, That gales and strong winds from the N. and N.E. depress the mean level about 3$\frac{1}{4}$ inches, and that similar winds from the S.W., S., and S.E., elevate it to the same amount.

Since the publication of these latter observations of M. Daussy, Mr. Lubbock has been induced to examine further into this interesting cause of variation in the mean level of the sea, and which had, previous to M. Daussy, escaped attention. He has announced, that Mr. Dennison having at his request, calculated the heights and times of the tides at Liverpool for the year 1781, and compared the results obtained by him with the barometric heights of the same year by Mr. Hutchinson, this conclusion is arrived at, namely, that for one-tenth of an inch depression of the mercurial column, there is a corresponding elevation of the mean level of the sea, amounting to one inch. With regard to the epochs of the tides, no sensible connexion with the atmospheric pressure was observed. This is a remarkable and satisfactory corroboration of the fact observed by M. Daussy. It may now be desirable to adopt the term, *Standard Level of the Sea*, (or some similar one,) when elevations are referred to the sea-level,—meaning by the new term, the mean level of the sea at a certain constant height of the barometer.

TRANSPARENT PAINTING.

It is not improbable, that some of the more beautiful paintings on glass, to be seen in cathedral windows, may have led to the introduction of transparent painting on paper and on canvas; a mode of exhibiting some subjects of a more striking character than can be effected by any of the usual means. The nature of the effects produced, and the means of execution, will appear as we proceed.

In treating any scene as a transparency, the same attention to the principles of aërial and linear perspective, as directed under the previous head of landscape, will be indispensable, with this peculiarity, that, in general, greater breadth of light and

more powerful effect must be studied. Truth is the safest guide in this, as in all other departments of imitative art; but truth may be rigidly kept to while the strongest oppositions of light, shade, color, and effect, which nature presents to the eye, may be selected.

The same colors as those of landscape painting are used for transparencies, and the processes are also the same; only it is requisite to be very attentive in washing in the tints with the utmost possible correctness, both with respect to form and to the power of color. It becomes the more necessary to insist upon this, when it is taken into consideration, that the surface of the paper must be preserved clear in every part, and that this clearness is always more or less injured by washing out or sponging.

The subject may be finished according as the taste and talent of the student may suggest, in order to range with others in a portfolio,—in all respects like a painting in water colors.

In selecting paper, it may be remarked, that, for small subjects, the sort called bank-post is the best adapted, from its thin and equal texture. On the other hand, for larger subjects, we recommend the thinnest hard-wove drawing paper that can be procured, carefully selected free from unevenness or inequality of texture, by holding it up between the eye and the light and examining every part of it, because much of the effect depends on the goodness of the paper.

When the paper has been selected according to the size of the proposed subject, it should be laid on a drawing-board and fastened there, with a piece of thick paper beneath, in order that the tints may be distinctly seen during the process, which must be conducted according to the method before laid down for landscape painting.

After having completed the subject so far as relates to the front, it may be cut off, leaving a margin of a quarter of an inch in breadth, for the purpose of glueing it down in the following manner.

Take a sheet of Bristol-board, or, if the subject is larger, a thicker material, for the purpose of preserving the surface of the whole even and flat. From the centre of this board let a piece be cut out corresponding with the size of the painting, which must be placed on a drawing-board, with its face downwards. Let it then be covered for a few minutes with a damp cloth, to cause it to expand a little; and in the meanwhile cover, with thick gum or glue, the edges of the aperture in the board, to correspond with the width of the margin cut off with the painting. The damp cloth may now be removed, and the painting may be turned with its face upwards, placing the board upon it accurately, in such a manner that the margin may adhere securely to the gum or glue in every part. The whole may then be laid on a flat surface to dry.

In this way the Bristol-board will form a frame of such width as may be adapted to the painting, and this frame may be afterwards ornamented according to the taste or fancy of the student.

It may be observed that the brilliancy of a transparent painting will be increased by the opacity of the border by which it is surrounded, and its width should be regulated by the size of the painting.

As soon as the whole is thoroughly dry, the painting must receive such additions at the back as may be requisite to bring it up to the full luminous effect intended. For this purpose, the most convenient position will be one inclined in a sloping direction, similar to an artist's easel, and immediately in front of a steady light.

When the painting has been placed in this position, it will immediately be perceived, that how powerfully soever it may have been previously tinted or touched in the front, a strong light will cause it to appear comparatively feeble. But as the original intention of the student will still be impressed on his mind, this weakness in the effect, which only becomes apparent by transmitted light, will suggest the addition of tints to produce the intended power. Where more is required, it must be cautiously applied at the back of the painting, taking all possible care to preserve the colors clear, and not to injure nor ruffles the texture of the paper, repeating the tints till the due power be obtained.

When considerable power is required, such colors of Indian red, Cologne earth, or vermilion, must be selected, as have a semi-opaque body; but care must taken not to lay them on so thickly as to produce blackness. When richness is required, lake, Prussian blue, and gamboge, which are perfectly transparent, are well adapted to communicate not only richness but delicacy and power to finish.

When, by carefully employing the means just pointed out, all possible harmony and effect have been imparted to the painting, it may be rendered partially or wholly luminous, by judiciously applying mastic spirit varnish. With a camel-hair pencil moderately charged with this varnish, let such parts as are in the highest lights be carefully touched as well as the major part of the sky, and the principal objects of the piece together with whatever part may require it in accordance with the character of the scene.

If the whole of the subject be covered, it will be requisite to spread the varnish with a flat camel-hair brush, passing it quickly from side to side, and from top to bottom, so that the varnish may be equally spread with all possible expedition. The picture must then be left to dry.

After the varnish has become dry, by mixing a little oxgall in the water used for the colors, additional beauty of tint, as well as harmony, may be imparted to such parts as appear crude or harsh, and considerable tenderness or spirit may be produced by paying attention to the rules laid down in a preceding page with respect to contrast and harmony.

In the instructions already given for landscape painting, it is presumed that enough has been said with respect to the mechanism and manipulations of the art to enable the student who has practised with perseverance, to have acquired a mastery of the pencil and a knowledge of colors, as well as the power of judging with some degree of accuracy, of the means proper to be adopted for producing any effect desired. Then, for the purposes of study, let the following subjects be selected :—

1. A scene composed of the trunk of a fallen tree, with broad-leaved wild plants around it in the foreground; a heath in the mid-distance; and a range of hills for the remote distance: the whole treated as a transparency, though the composition be extremely simple, offers great scope for the particular effect of sunset opposed by breadth of shade. A strong effect is at once imparted by the deep tones of the landscape, and the gradual diminution of grey towards the horizon, while the streaky clouds of evening put in as they appear in nature, and the bright tones along the horizon touched with varnish,

give a rich variety of harmony and contrast, the more pleasing from the associations with the beauties of evening which it awakens.

2. A water-fall or cataract is another subject well adapted for representation in a transparency; the great breadth of light being on the smoother water of the cascade, and on the foam caused by its rushing amidst broken rocks, surrounded by gloomy precipices, overhung by weather-beaten branches of trees, and the pendant foliage of rock shrubs. The variety of tints in the foliage, caused by the fading of the leaves in autumn, ought to be studied with care, in order to give a rich diversity of color to their several portions.

The higher lights on the agitated water preserved during the process of coloring, will show more brilliantly under the operation of varnishing than the greater mass of water; but the sparkling touches required, where the rocks oppose the rushing of the torrents, may be done over with varnish *on the other side of the painting* in order to produce a vivid effect. It will be necessary, with respect to these touches, to attend to their characteristic forms—such as here and there dottings, in other parts irregular splashings and ripplings of the water, gradually diminishing as the parts recede from the principal mass of light.

As soon as the whole shall have become dry, it may be requisite to introduce tints of greenish grey where the tones require to be heightened, or where such parts appear too bright require to be subdued, as well as to correct such forms as may seem to need alteration.

(To be continued.)

JAPANNING.

(Resumed from page 228, and concluded.)

Of Painting Japan Work.—Japan work should be painted with colors in varnish; and, in that case, all pigments or solid colors whatever may be used, and the peculiar disadvantages which attend several kinds, with respect to oil or water, cease with regard to this sort of vehicle, for they are secured by it, when properly managed, from the least hazard of changing or flying. The preparation of colors for this use consists, therefore, in bringing them to a due state of fineness, by grinding on a stone in oil of turpentine. The best varnish for binding and preserving the colors, is shell-lac; this, when judiciously managed, give such a firmness and hardness to the work, that, if it be afterwards further secured with a moderately thick coat of seed-lac varnish, it will be almost as hard and durable as glass. The method of painting in varnish is, however, more tedious than in oil or water. It is therefore now very usual in the japan work, for the sake of dispatch, and in some cases for the freer use of the pencil, to lay on the colors with oil well diluted with spirits of turpentine. This oil or japan gold size, as it is called, may be made in the following manner:—Take one pound of linseed oil, and four ounces of gum animi; set the oil to boil in a proper vessel, and then add the gum animi gradually in powder, stirring it well, until the whole be commixed with the oil. Let the mixture continue to boil till it appears of a thick consistence, and then strain the whole through a coarse cloth, and keep it for use. The colors are also sometimes laid on in gum water, but the work done in this manner is not near so durable as that done in varnish or oil. However, those who practise japanning for their amusement only, and consequently may not find it worth their while to encumber themselves with the preparations necessary for the other methods, may paint with water colors. If the colors are tempered with strong isinglass size and honey, instead of gum water, the work will not be much inferior to that done by the other method. Water colors are sometimes laid on grounds of gold, in the manner of other paintings, and look best without any varnish over them; and they are sometimes so managed as to have the effect of embossed work. The colors in this way of painting are prepared by means of isinglass size corrected with honey or sugar candy. The body with which the embossed work is raised, is best formed of strong gum water, thickened to a proper consistence with bole armenian and whiting in equal parts; which, being laid on in the proper figures, and repaired when dry, may be then painted with the intended colors tempered in the isinglass size, or in the general manner with shell-lac varnish.

Of Varnishing Japan Work.—The last and finishing process in japanning consists in the laying on and polishing the outer coats of varnish, which are equally necessary whether the plain japan ground be painted or not. This is generally best done with common seed-lac varnish, except on those occasions where other methods have been shown to be more expedient; and the same reasons which decide as to the propriety of using the different varnishes as regards the colors of the ground, hold equally with those of the painting; for where brightness is a material point, and a tinge of yellow would injure it, seed-lac must give way to the whiter resins; but where hardness and tenacity are essential, it must be adhered to; and where both are necessary, a mixed varnish must be adopted. This mixed varnish should be made of the picked seed-lac, as directed in the case of white japan grounds. The common seed-lac varnish may be made thus:—Take three ounces of seed-lac, and wash it well in several waters; then dry it and powder it coarsely, put it, with a pint of rectified spirit of wine, into a bottle, so that it be not more than two-thirds full; shake the mixture well together, and place the bottle in a gentle heat till the seed appear to be dissolved, the shaking being in the meantime repeated as often as may be convenient; and then pour off all the clear, and strain the remainder through a coarse cloth. The varnish thus prepared must be kept for use in a bottle well stopped. The whiter seed-lac varnishes are used in the same manner as the common, except with regard to the substance used in polishing; which, where a pure white, or great clearness of other colors is in question, should be itself white; while the browner sorts of polishing dust, as being cheaper, and doing their business with greater dispatch, may be used in other cases. The pieces of work to be varnished should be placed near the fire, or in a warm room, and made perfectly dry, and then the varnish may be laid on with a flat camel-hair brush made for the purpose: this must be done very rapidly, but with great care; the same place should not be passed twice over, in laying on one coat, if it can possibly be avoided: the best way of proceeding is to begin in the middle, pass it to the other end, taking care that, before each stroke, the brush be well supplied with varnish. When one coat is dry another must be laid over it in like manner, and this must be continued at least

five or six times. If, on trial, there be not a sufficient thickness of varnish to bear the polish, without laying bare the painting or ground color underneath, more must be laid on. When a sufficient number of coats is thus laid on, the work is fit to be polished; which must be done, in common cases, by rubbing it with a piece of cloth, or felt, dipped in tripoli, or pumice stone, finely powdered. But towards the end of the rubbing a little oil of any kind should be used with the powder; and when the work appears sufficiently bright and glossy, it should be well rubbed with the oil alone, to clean it from the powder, and give it a still greater lustre. In the case of white grounds, instead of the tripoli, fine putty or whiting should be used, but they should be washed over to prevent the danger of damaging the work from any sand, or other gritty matter, that may happen to be mixed with them. It greatly improves all kinds of japan work to harden the varnish by means of heat, which, in every degree that it can be applied, short of what would burn or calcine the matter, tends to give it a more firm and strong texture. Where metals form the body, therefore, a very hot stove may be used, and the work may be continued in it a considerable time, especially if the heat be gradually increased; but where wood, or *papier machée* is in question, heat must be sparingly used.

AUTOGRAPHY.

Autographic Ink, or that which is suitable for transferring on to stone the writings or drawings which have been executed on paper prepared for that purpose, should possess the following properties. The ink ought to be mellow, and somewhat thicker than that used immediately on stone; so that when it is dry on the paper, it may still be sufficiently viscous to cause adherence to the stone by simple pressure. The following is the composition. Dry soap, and white wax free from tallow, each 100 drachms, mutton suet, 30 drachms, shell-ac and mastic, each 50 drachms, lamp black, 30 to 35 drachms; these materials are to be melted in the same way as for lithographic ink.

Autographic Paper.—The operation by which a writing or drawing is transferred from paper to stone, not only affords the means of abridging labour, but also of producing the writings or drawings in the same directions in which they have been traced; whereas, when they are executed immediately on stone, they must be performed in a direction opposite to that which they are eventually to have. Thus it is necessary to draw those objects on the left, which, in the impression, are to be on right hand. To acquire the art of reversing subjects when writing or drawing, is both difficult and tedious; while, by the aid of transparent, and of autographic paper, impressions may be readily obtained in the same direction as that in which the writing or the drawing has been made. In order to make a transfer on to stone of a writing, a drawing in lithographic ink, or in crayons, or an impression from a copper plate, it is necessary, 1st, that the drawing or transcript should be on a thin and flexible substance, such as common paper; 2nd, that it should be capable of being easily detached from this substance, and transferred entirely on to the stone, by means of pressure. But as the ink with which a drawing is traced penetrates the paper to a certain depth, and adheres to it with considerable tenacity, it would be difficult to detach them perfectly from each other, if between the paper and the drawing, some substance was not interposed, which, by the portion of water which it is capable of imbibing, should so far lessen their adhesion to each other, that they may be completely separated in every point. It is to effect this that the paper is prepared, by covering it with a size, which may be written on with facility, and on which the finest lines may be traced without blotting the paper. Various means may be found of communicating this property to paper. The following preparation has always been found to succeed, and which, when the operation is performed with the necessary precautions, admits of the finest and most delicate lines being perfectly transferred, without leaving the faintest trace on the paper. For this purpose, it is necessary to take a strong, unsized paper, and to spread over it a size prepared of the following materials: starch, 120, gum arabic, 40, and alum, 21 drachms. A moderately thick paste is made with the starch, by means of heat; into this paste is thrown the gum arabic and the alum, which have been previously dissolved in water, and in separate vessels. The whole is mixed well together, and it is applied warm to the sheets of paper, by means of a brush, or a large flat hair pencil. The paper may be colored by adding to the size a decoction of French berries, in the proportion of ten drachms. After having dried this autographic paper, it is put into a press, to flatten the sheets, and they are made smooth by placing them, two at a time, on a stone, and passing them under a scraper of the lithographic press. If, on trying this paper, it is found to have a tendency to blot, this inconvenience may be remedied by rubbing it with finely-powdered sandarac. Annexed is another recipe, which will be found equally useful, and which has the advantage of being applicable to thin paper, which has been sized. It requires only that the paper be of a firm texture; namely, gum tragacanth, 4 drachms; glue, 4; Spanish white, 8; and starch, 4 drachms.

The tragacanth is put into a large quantity of water to dissolve, thirty-six hours before it is mixed with the other materials; the glue is to be melted over the fire in the usual manner. A paste is made with the starch; and after having, whilst warm, mixed these several ingredients, the Spanish white is to be added to them, and a layer of the sizing is to be spread over the paper, as already described, taking care to agitate the mixture with the brush to the bottom of the vessel, that the Spanish white may be equally distributed throughout the liquid. We will hereafter point out the manner in which it is necessary to proceed, in order to transfer writings and drawings. There are two autographic processes which facilitate and abridge this kind of work when it is desired to copy a fac-simile, or a drawing in lines. The first of these methods is to trace, with autographic ink, any subject whatever, on a transparent paper, which is free from grease and from resin, like that which, in commerce, is known by the name of *papier végétal*, and to transfer it to stone; this paper to be covered with a transparent size: this operation is difficult to execute, and requires much address, in consequence of the great tendency which this paper has to cockle or wrinkle when it is wetted. Great facilities will be found from using tissue paper, impregnated with a fine white varnish, and afterwards sized over. In the second process, transparent leaves, formed of gelatin,

cr fish glue, are employed, and the design is traced on them with the dry point, so as to make an incision; these traces are to be filled up with autographic ink, and then transferred.

Autographic Processes.—To transfer a drawing or writing to stone, it is made with ink on paper, both prepared in the way we have described. A crayon drawing may, on an emergency, be executed autographically; but this mode of procedure is too imperfect to admit of procuring, by its means, neat and perfect proofs; besides, it is as expeditious to draw immediately on the stone.

In order to write, or to draw on autographic paper, a little of the ink of which we have given the composition is diluted with water, taking care to use only rain-water, or such as will readily dissolve soap. The solution is facilitated by slightly warming the water in the cup; and the ink is dissolved by rubbing the end of a stick of it in the manner practised with Indian ink. There should be no more dissolved at a time than will be used in a day, for it does not re-dissolve so well, neither is the ink so good, particularly for delicate designs, after it has been left to dry for several days. This ink should have the consistence of rather thick cream, so that it may form very black lines upon the paper; if these lines are brown, good impressions will not be obtained. A sheet of white paper is placed under the hand while writing, in order that it may not grease the autographic paper.

(To be continued.)

LIFTING OF THE KREMLIN BELL.

In the month of July, 1836, a successful attempt was made to raise the enormous bell which had been long buried in the earth, in the Kremlin, at Moscow. It was cast, in 1733, at the command of the Empress Ance, by a Russian founder, Michael Motorine. It is, according to Clarke, 21 ft. 4½ in. high; at two feet from the bottom its circumference measures 67 ft. 4 in.; its diameter at that height is consequently about 21 ft. 6 in. Its thickness, at the part intended to be struck by the hammer, 23 in. The Russians estimate the weight at 12,000 poods, which is nearly 200 English tons. The reputed elegance of its form, the style of its bas-reliefs, and the richness of its metal, composed of gold, silver, and copper, contributed to make it remarkable as a specimen of the advanced state of the art of casting in Russia, at the epoch of its execution.

M. Montferrand, a gentleman greatly distinguished in Petersburgh by the numerous works he has executed, was intrusted with the direction of the operations. As the bell was lying in a cavity in the ground, and more than thirty feet below the surface, a large excavation was made to clear it. Over this was constructed a strong and lofty scaffold for the attachment of the blocks, and for the temporary suspension of the bell at a proper height. At half-past five in the morning of the 5th of July, the authorities of Moscow and a large number of spectators being assembled on the spot, prayers were offered up for the success of the attempt, and the operations commenced on a signal given by M. Montferrand. Six hundred soldiers instantaneously set-to at a large number of capstans. The enormous weight was mastered, and the bell was soon seen to rise slowly in the pit. Forty-two minutes elapsed during its elevation to its necessary height. No accident occurred. The first operation being finished the next was to build a platform beneath the suspended bell. This was completed in eight hours, and the bell lowered upon it. On the following day it was placed on a sledge, and drawn, by means of an inclined plane, up to the pedestal intended to support it, and there finally left on the 26th of the same month.

This colossal work of art is, after all, but a mere curiosity. Its use as a bell is impossible, from a fracture, about seven feet high and two feet wide, in the lower part, where, as has been stated, it is 23 in. thick. The cause of this gigantic injury rests entirely upon conjecture.

SCOURING, OR RENOVATING ARTICLES OF DRESS.

This art has been much more studied by Frenchmen, who wear the same coats for two or three years, than by Englishmen, who generally cast them off after so many months. The workmen who remove greasy stains from dress are *teinturiers-degraisseurs*, because they are often obliged to combine dyeing with scouring operations. The art of cleansing clothes being founded upon the knowledge of solvents, the practitioner of it ahould be, as we shall presently illustrate by example, acquainted with the laws of chemical affinity.

Among the spots which alter the color fixed upon the stuffs, some are caused by a substance which may be described as *simple*, in common language; and others by a substance which results from the combination of two or more bodies, that may act separately or together upon the stuff, and which may therefore be called *compound*.

Simple Stains.—Oils and fats are the substances which form the greater part of simple stains. They give a deep shade to the ground of the cloth; they continue to spread for several days; they attract the dust, and retain it so strongly, that it is not removable by the brush; and they eventually render the stain lighter colored upon a dark ground, and of a disagreeable grey tint upon a pale or light ground.

The general principle of cleansing all spots, consists in applying to them a substance which shall have a stronger affinity for the matter composing them, than this has for the cloth, and which shall render them soluble in some liquid menstruum, such as water, spirits, naphtha, oil of turpentine, &c.

Alkalis would seems to be proper in this point of view, as they are the most powerful solvents of grease; but they act too strongly upon silk and wool, as well as change too powerfully the colors of dyed stuffs, to be safely applicable in removing stains. The best substances for this purpose are—1. Soap. 2. Chalk, fuller's earth, soap-stone or steatite (called in this country French chalk.) These should be merely diffused through a little water into a thin paste, spread upon the stain, and allowed to dry. The spot requires now to be merely brushed. 3. Ox-gall and yolk of egg have the property of dissolving fatty bodies without affecting perceptibly the texture or colors of cloth, and may therefore be employed with advantage. The ox-gall should be purified, to prevent its greenish tint from degrading the brilliancy of dyed stuffs, or the purity of whites. Thus prepared it is the most precious of all sub-

stances known for removing these kinds of stains. 4. The volatile oil of turpentine will take out only recent stains; for which purpose it ought to be previously purified by distillation over quicklime. Wax, rosin, turpentine, pitch, and all resinous bodies in general, form stains of greater or less adhesion, which may be dissolved out by pure alcohol. The juices of fruits, and the colored juices of all vegetables in general, deposit upon clothes marks in their peculiar hues. Stains of wine, mulberries, black currants, morellos, liquors, and weld, yield only to soaping with the hand, followed by fumigation with sulphurous acid: but the latter process is inadmissible with certain colored stuffs. Iron mould or rust stains may be taken out almost instantaneously with a strong solution of oxalic acid. If the stain is recent, cream of tartar will remove it.

Compound Spots.—That mixture of rust of iron and grease called *cambouis* by the French, is an example of this kind, and requires two distinct operations; first, the removal of the grease, and then of the rust, by the means above indicated.

Mud, especially that of cities, is a compound of vegetable remains, and of ferruginous matter in a state of black oxide. Washing with pure water, followed, if necessary, with soaping, will take away the vegetable juices; and then the iron may be removed with cream of tartar, which itself must, however, be well washed out. Ink stains, when recent, may be taken out by washing, first with pure water, next with soapy water, and lastly with lemon juice; but if old, they must be treated with oxalic acid. Stains occasioned by smoke, or by sauces browned in a frying-pan, may be supposed to consist of a mixture of pitch, black oxide of iron, empyreumatic oil, and some saline matters dissolved in pyrolignous acid. In this case several reagents must be employed to remove the stains. Water and soap dissolve perfectly well the vegetable matters, the salts, the pyrolignous acid, and even the empyreumatic oils in a great measure; the essence of turpentine will remove the rest of the oils and all the pitchy matter; then oxalic acid may be used to discharge the iron. Coffee stains require a washing with water, with a careful soaping, at the temperature of 120° F., followed by sulphuration. The two latter processes may be repeated twice or thrice. Chocolate stains may be removed by the same means, and more easily.

As to those stains which change the color of the stuff, they must be corrected by appropriate chemical reagents or dyes. When the black or brown cloth is reddened by an acid, the stain is best counteracted by the application of water of ammonia. If delicate colors are injured by soapy or alkaline matters, the stains must be treated with colorless vinegar of moderate force. An earthy compound for removing grease spots is made as follows:—Take fuller's earth, free it from all gritty matter by elutriation with water; mix with half a pound of the earth so prepared, half a pound of soda, as much soap, and eight yolks of eggs well beaten up with half a pound of purified ox-gall. The whole must be carefully triturated upon a porphyry slab; the soda with the soap in the same manner as colors are ground, mixing in gradually the eggs and the ox-gall previously beat together. Incorporate next the soft earth by slow degrees, till a uniform thick paste be formed, which should be made into balls or cakes of a convenient size, and laid out to dry. A little of this detergent being scraped off with a knife, made into a paste with water, and applied to the stain, will remove it. Purified ox-gall is to be diffused through its own bulk of water, applied to the spots, rubbed well into them with the hands till they disappear, after which the stuff is to be washed with soft water. It is the best substance for removing stains on woollen clothes.

The redistilled oil of turpentine may also be rubbed upon the dry clothes with a sponge or a tuft of cotton, till the spot disappear; but it must be immediately afterwards covered with some plastic clay reduced to powder. Without this precaution, a cloud would be formed round the stain, as large as the part moistened with the turpentine.

Oxalic acid may be applied in powder upon the spot previously moistened with water, well rubbed on, and then washed off with pure water.

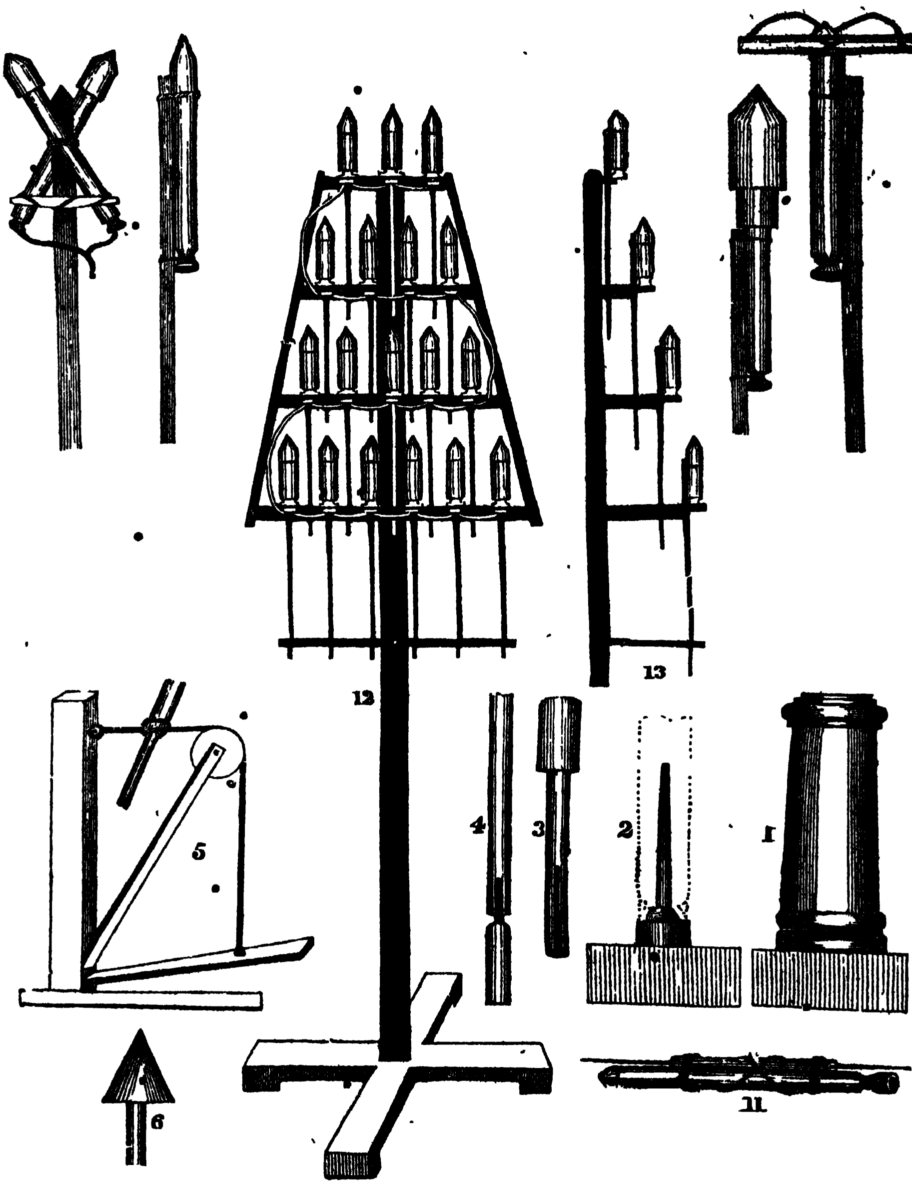
Sulphurous acid is best generated at the moment of using it. If the clothes be much stained, they should be suspended in an ordinary fumigating chamber. For trifling stains, the sulphur may be burned under the wide end of a small card or paper funnel, whose upper orifice is applied near the cloth.

Manipulations of the Scourer.—These consist, first, in washing the clothes in clean soft water, or in soap-water. The cloth must next be stretched on a sloping board, and rubbed with the appropriate reagent as above described, either by a sponge or a small hard brush. The application of a red-hot iron a little way above a moistened spot often volatilizes the greasy matter out of it. Stains of pitch, varnish, or oil paint, which have become dry, must first be softened with a little fresh butter or lard, and then treated with the powder of the scouring ball. When the gloss has been taken from silk, it may be restored by applying the filtered mucilage of gum tragacanth; stretching it upon a frame to dry. Ribbons are glossed with isinglass. Lemon juice is used to brighten scarlet spots after they have been cleaned.

MISCELLANIES.

Yeast.—Take a quarter of an ounce of hops, boil them for 20 minutes in two quarts of water, let it stand till it is about the warmth of new milk, stir in it a pint of flour, then stir in it a pint of barm, or brewer's yeast, the same way as it is put in the dough for making bread. Let it stand to ferment, then bottle it in stone bottles, and tie the corks down with a string. It should be put to heave in the flour a night before you bake, and in cool weather keep it warm, the same way as any other leaven. The above is a valuable recipe, being an excellent substitute for brewer's yeast. The latter article is becoming scarce, owing to the spread of temperance habits amongst the people.—*Glasgow Herald.*

India Rubber.—This most remarkable article, which only a few years ago was sent to this country as ballast, now sells in a fine state as high as 10s. to 14s. per pound when spun into thread. One firm spins as much India rubber thread every week as would reach from London to Canton, the country it is imported from. There are twelve patents for this article, and these patents have cost more to defend in law than the amount paid for India rubber since the article has been known to us of any value. Experiments are now making in England and in France to apply the articl to cure consumption.



PYROTECHNY, OR THE ART OF MAKING FIRE-WORKS.

PYROTECHNY, OR THE ART OF MAKING FIRE-WORKS.

This art, it is said, has been practised among the Chinese for many ages—with Europeans it is of comparatively modern date. The Italians and French are celebrated for the taste and splendour of their pyrotechnic exhibitions, and the occasional displays we witness here, show that when any circumstance calls the art into exercise, we can form most magnificent combinations of devices, rockets, and sundry other not less pleasing spectacles.

The three prime materials of this art are, nitre, sulphur, and charcoal, along with filings of iron, steel, copper, zinc, and resin, camphor, lycopodium, &c. Gunpowder is used either in grain, half crushed, or finely ground, for different purposes. The longer the iron filings, the brighter red and white sparks they give; those being preferred which are made with a very coarse file, and quite free from rust. Steel filings and cast-iron borings contain carbon, and afford a more brilliant fire, with wavy radiations. Copper filings give a greenish tint to flame; those of zinc, a fine blue color; the sulphuret of antimony gives a less greenish blue than zinc, but with much smoke; amber affords a yellow fire, as well as colophony, and common salt; but the last must be very dry. Lamp black produces a very red color with gunpowder, and a pink with nitre in excess. It serves for making golden showers. The yellow sand or glistening mica, communicates to fire-works golden radiations. Verdigris imparts a pale green; sulphate of copper and sal-ammoniac, a palm tree green. Camphor yields a very white flame and aromatic fumes, which mask the bad smell of other substances. Benzoin and storax are used also on account of their agreeable odour. Lycopodium burns with a rose color and a magnificent flame; but it is principally employed in theatres to represent lightning, or to charge the torch of a fury.

Of all fire-works, rockets are among the most noble and effective. The ingredients for these, the apparatus employed, and the detail of the manufacture of them may be considered the foundation of all artificial fire-works, and to make them well involves the same principles, and requires the same caution, as in making all others. At the present time, then, we will direct our attention to rockets in particular.

Size of Rockets.—The size of rockets is indicated by ounces or pounds, thus we say, an eight ounce rocket, a pound rocket, and so on; by this expression it is not meant that the rockets weigh so much as their name indicates, but that the bore or cavity of them will just suffer a leaden bullet of that weight to pass down them. For example, a pound rocket will admit a leaden bullet that weighs a pound. Rockets may be made of any size from one ounce up to fifty or more pounds. Those for amusement are usually one pound or under—the larger kinds are employed for military purposes only.

Forming the Cases or Cartridges.—These may be made of any kind of stiff thick paper, either cartridge paper, or what is equally as good and much cheaper, namely, common *bag-cap* paper. To roll up the cases, you must have a smooth round ruler or as it is called a *former*, exactly the size of the cavity of the rocket and 10 or 12 times as long. Then lay a sheet of the paper upon a table or board and paste 4 or 5 inches along the end of it, leaving the rest of the sheet of paper without paste, then roll it smoothly over the former, dry end first; until the whole is rolled up, when, of course, the paste will stick and a thin case be formed; keep rolling it along the table with the hands, in the same way as a rolling pin is used, for 2 or 3 minutes until the various folds of the paper set close and tight to each other, then put on another sheet in the same way and so on until the case is thick enough, and this is known by the measurement across it. If the *former* without the case measure 5 parts; when the case is upon it, they must measure together 8 parts. That is, the paper must be rolled on until it forms a case, the thickness of the sides of which are a trifle more than one-third of the thickness of the *former*. The length of the rocket case, and consequently, the width that the sheets of brown paper are to be cut before pasting varies with the size o. the rocket—in small rockets the length of the case may be 6 times, the diameter in larger rockets 4 or 5 times is sufficient.

When the case has been made so far, it is to be *choked* while yet damp, that is, to be contracted in diameter near one end, and for this purpose, a little simple contrivance is requisite, called a *choking cord*, and also the *former* is made with a hole drilled at one end, and a second joint made to fit on by means of a wire projecting at one end of it, and which fits into the hole of the *former*. (Fig. 4.) To choke the case, draw the *former* partly out, until you can see about an inch of the inner cavity of the case, then put on the second joint, (the wire of it going into the hole of the *former*,) and pass this on until its end is about half an inch within the case, and consequently leaving a space of about half an inch between the 2 joints occupied by the wire alone.—Then going to an apparatus similar to that figured in No. 5, turn the cord once round the case where the cavity is, put the foot upon the treadle, which tightens the cord, and squeezes the paper case at the point required, and that it may squeeze it equally and neatly on all sides, the case should be held in the hands and moved up and down upon the cord, until the operater sees that it is sufficiently and properly compressed. Let it be observed, that although the choking apparatus used by the fire-work maker is represented and above alluded to, yet to the amateur it is by no means necessary. What will do quite as well, is a thin cord fastened at one end to a staple in the wall, and by the other, tied round the waist of the operator; as he may lean back, of course the cord would be tightened, and the desired purpose accomplished. When the case is sufficiently compressed it is to be tied with 2 or 3 turns of strong string. The case is now complete, except that the part of it where it is choked, is perhaps rather rough and uneven inside; this must be compressed down, for much of the effect of the rocket will depend upon the perfect regularity of this part, as it is through the hole left by the wire in the middle of the choke that the fire is afterwards to issue. To compress this part properly a mould is necessary—this important apparatus may be described as follows :—

The Rocket Mould.—Is represented in Fig. 1. It consists of a solid foot of wood, upon the centre of this stands a short cylinder about half an inch high, and exactly of the size of the mould, to be placed over it, as afterwards described; this short cylinder has a shoulder above and terminates in a round top. Out of the middle of the top is a tapering thick brass wire, projecting some inches upwards as is seen in Fig. 2. The whole is so arranged, that

when one of the newly-made cases is put upon the wire and forced down, the wire fills up the choke hole, the round top fits into the small part of the case below the choke, the shoulder of the cylinder bears the extreme end of the case, and the short cylinder agrees in size with the outside of the case. There fits over this (case and all) a strong wooden or metal tube; so that it is seen that there is no cavity anywhere, except the inside of the rocket case, and even in this, a thick wire runs up to nearly the top of that part of the case where the composition is rammed, or nearly $\frac{7}{8}$ of the whole case from the choke upwards. The wire above mentioned is called the *piercer*. All rockets must be placed in the mould to be filled, as well as to smooth and consolidate the part choked. With the mould are used *rammers*, (Fig.3,) formed of hard wood of the shape of a popgun stick, the size of them rather less than the diameter or the cavity, and having a hole bored up their centre, in order to admit the piercer. It is evident that there must be a complete mould, piercer, and one or more rammers for every sized rocket.

But to proceed with the manufacture: When the case has been tied with string, put it in the mould and the rammer down into it, and give this, the latter, a blow or two with a mallet, which driving it down while yet damp with the paste, will render the whole compact and smooth, and the case being taken out may be placed in an oven, or near the fire to dry. If it be desired to ornament it in any way or cover it with white paper, it is evident that this must be done before choking.

Charging the Rocket.—The next process after drying the cases is to charge them with the requisite composition. This is done very easily. Put the cases in the mould with the piercer in it and put enough composition to fill about 1 inch of the case, then taking the rammer ram it down with 3 or 4 strong blows with a wooden mallet. Then put in the same quantity of composition again and ram that down in the same manner, and so on till the case is filled to the top of the piercer and one diameter above it. Then separate some of the central folds of the paper which it has been observed is not parted, and turn them down upon the composition, ramming them down hard upon it, or what will do as well, put in a piece of paper as wadding. When this is rammed down, and firm, bore with a *brass* brad-awl 3 or 4 holes through it, these holes serve to make the requisite communication between the 2 parts of the rocket. (It ought always to be borne in mind, that iron tools must never be used in making fire-works of any kind, as they are liable to throw out sparks when striking against a hard stoney substance; besides which, the sulphur used would soon combine with the iron and render it brittle. Brass may be used, but still better *copper* tools.) The rocket is now rammed, and may be taken out of the mould, set aside, and another rammed in like manner.

Loading Rockets.—The cavity left at the top of the rocket is now to be filled. If the rocket be small, a charge of half an ounce of gunpowder is put in it, and the end fastened up, or in larger rockets, stars or fiery rains are placed in the cavity, with a little loose gunpowder sprinkled over them, and the end fastened down either by turning down some more of the paper of the case or in any other convenient manner: there should now be placed upon the top of the whole a conical cap, which by cleaving the air, assists the rocket in rising into it.

Priming Rockets.—The rocket is now supposed to be closed at one end. It only requires to be primed at the other, and that it will be observed is the end which was choked, and which is still open, and has a hole passing up it which the *piercer* occupied. To prime it, fill up the hole with loose gunpowder and paste a piece of touch paper over it.

Rocket Sticks.—Next fasten the stick to the rocket by 2 strings as is seen in any of the Figures. The sticks being previously prepared of proper length and size, as follows. The smaller ones are easily and best made of those laths, called by bricklayer's double laths, and the larger ones pantile lathes, but any slip of dry deal will answer the purpose.

2lb. rockets require sticks 9 feet 4 inches long, 1 inch square at top, and rather more than half an inch square at bottom.

1lb. rocket sticks are 8 feet 2 inches long, $\frac{3}{4}$ inch square at top and $\frac{2}{3}$ at bottom.

8 oz. rocket sticks, 6 feet 2 inches long, $\frac{5}{8}$ inch square at top and $\frac{3}{8}$ at bottom.

4 oz. rocket sticks, 5 feet 3 inches long, $\frac{3}{8}$ by $\frac{1}{2}$ inch at top and $\frac{1}{4}$ inch square at bottom.

2 oz. rocket sticks are 5 feet 1 inch long, 3-tenths by $\frac{1}{2}$ inch at top, 2-tenths of an inch at bottom.

1 oz. rocket sticks, 3 feet 6 inches long, and so on for others of various sizes. The weight and the length of the stick must be such, as that when tied on the rocket shall balance on the finger, at a point about an inch from the point choked.

Rockets with small heads, and such as are not charged with a report, and also small signal rockets do not require sticks so heavy as the above; so also petard rockets and others with large heavy heads require them still longer. The beauty, steadiness, and lofty flight of a rocket depends much upon the right adjustment of the stick. If this be too heavy, the rocket will move slowly, and not ascend to a sufficient height, if too light its course will be unsteady and irregular, so that the majesty of it will be lost. When the sticks have been planed of proper dimensions, there should be a channel cut on one side near the top of the sticks, to admit the rocket, and two notches to tie it on with; one round the choke, the other near the top of the stick which should always nearly touch the head of the rocket.

Compositions for filling Rockets.—It is an axiom among fire-work makers, that the smaller the case, so much quicker must be the composition to fill it, or in other words, the mixture that will do for a small case will burn too rapidly when placed in one of larger cavity. Hence it follows that the same composition will not do for large and also for small rockets. The following are some of the most approved receipts:—

To combine the ingredients of all fire-works well together, they should be first pounded separately. (Gunpowder when pounded is called *mealpowder*, and as it may be bought in this state, it is better to use it as it saves much trouble.) When pounded separately, mix them well together by hand, and rub them through a very fine wire sieve, or in absence of this, a common sieve.

For Rockets of 1 *or* 2 *pounds.*—

Mealpowder, 2lbs.,
Saltpetre, 8 ounces,
Brimstone, 4 ounces,
Charcoal, 2 ounces,
Steel-filings, 1 ounce and a half.

For Rockets of from 1 *pound to* 4 *ounces.*—
Mealpowder, 1lb.,
Saltpetre, 4 ounces,
Brimstone, 3 ounces,
Charcoal, 1 ounce and a half.

For Rockets under 8 *ounces.*—
Mealpowder, 1lb. 4 ounces,
Saltpetre, 4 ounces,
Charcoal, 2 ounces.

The above is the usual form of the common small rocket. Before we proceed to describe the loading of the heads of rockets with stars, fiery rain, &c., it may be advisable to offer a hint or two further, particularly to enable the amateur to ascertain the certainty of his success before his rockets may be finished, or he have an opportunity of letting one off. This success will depend chiefly upon the degree of union or the perfect blending of the various ingredients. We advise that they should, after having been pounded, be mixed together by the hand—let not the maker soon get tired of this work of rubbing them together on the board, much depends upon it, and it would be even better if the powders were incorporated on a board with a roller or muller rubbed upon them. When the ingredients are sufficiently blended, may be known thus; take a sieve and sift a little of the composition along a board (this should be done in the open air,) so that it hardly covers the board, then set fire to it at one end, if it burn gradually and quietly along to the other end, it is ground enough, but if it burn with little *phits* and starts, it must be mixed more intimately. If the rockets be finished before this has been tried, letting off one will ascertain the same fact; because, if not well mixed the rocket will *smoke*, and this must never be the case under any circumstances. It has been already observed, that every rocket should be terminated by a conical cap of paper. This cap is made of a circle of paper about 3 inches diameter, and cut with a slit from the circumference to the centre, when it may be folded of any sized cone required, and using a little paste to the edges, it will be rendered sufficiently solid. A piece of wood shaped like Fig. 6, is usually employed to form the conical cap upon, but this is not by any means necessary.

Rockets, of whatever kind they may be, are exactly similar to each other as to their compositions, their cases and the manner of ramming. They vary, however, in other respects, and consequently have assigned to them different names according to this variation, or according to the devices which they produce, or emit; as follows.

Headed or Petard Rockets.—The top of a common small rocket is not sufficiently large to hold those beautiful stars and fiery rains, which occasion so much delight. To have these appendages therefore the rocket should be, at least, of half a pound size, and instead of the upper part of the case being the only receptacle of any *furniture*, as it is called, it may have a paper box attached to it of a larger size than the case itself, as is represented in Fig. 8. It may be made in the same way as the case itself, but slight in substance, and connected with the case by a rim of wood or thick pasteboard, such as the cover of a book, cut round to fit the head and with a hole in it to fit the case, the whole neatly pasted together with strips of paper, or else this new case for the head may be choked on to a case at once, and tied there.

Rocket Stars. Common.—Nitre 1lb.; sulphur 4½ oz.; antimony, 4 oz.; isinglass, ½ oz.; camphor, ½ oz.; spirits of wine, ¾ oz.

White.—Mealed powder, 4 oz.; saltpetre, 12 oz.; sulphur, 6½ oz.; camphor, 5 oz.; or else, mealpowder, 4 oz.; nitre, 16 oz.; sulphur, 7 oz.; or, mealpowder, 3 oz.; nitre, 16; sulphur, 8 oz.

Blue.—Mealpowder, 8; nitre, 4; sulphur, 2½ oz.

Amber.—Nitre, 8; sulphur, 2; yellow amber, 1; sulphuret of antimony, 1; and mealpowder, 3 oz.

Crimson.—Sulphur, 1; sulphuret of antimony, 1; chlorate of potass, 1; nitrate of strontian, 5 oz.

Green.—Chlorate of potass, 5; sulphuret of antimony, 4; sulphur, 13; nitrate of barytes, 80 parts.

Purple.—Lamp black, 1; realgar, or red arsenic, 1; nitre 1; sulphur, 2; nitrate of strontian, 16 parts; chlorate of potass, 5.

Tailed.—Nitre, 4; sulphur, 6; sulphuret of antimony, 2; rosin, 4 parts.

Tailed, with Sparks.—Mealpowder, 1; nitre, 1; camphor, 2 oz.

To make the stars it is requisite to mix and incorporate the compositions well together, those containing the chlorate of potass with the hand only, (because if ground such may explode,)—and form the composition into a paste with spirits of wine, brandy, or vinegar, so that it shall resemble dough in stiffness; then cut it into pieces about the size of small marbles, roll them round in the hand, dust them over with mealpowder, and set them aside to dry. To charge the rocket, 20 or more may be placed in the head of the rocket, and a dram full of grained gunpowder being sprinkled between them; the top is to be closed by the conical cap, and the rocket will be finished; and provided the gunpowder has free communication with the charging composition, it will explode when the rocket has reached its proper altitude.

Fiery Rains are often used instead of stars, and with a fine effect. They are made by substituting small cases, like squibs, for the stars. The cases may be made by rolling a few inches of paper round a pencil, and turning in the lower end—ramming it down on the table or otherwise. When dry, these cases, which may be from 2 to 3 inches long, are to be rammed with either of the following compositions, and primed with a little damp powder, and a piece of touch paper slightly pasted over it—taking care that paste never touches the part of the paper which is to burn. When ready they are to be placed in the head of the rocket with the mouth downwards, and gunpowder strewed among them, as among the stars.

Gold Rain.—Sawdust, 1; sulphur, 2; mealpowder, 2; glass dust, 3; nitre, 8 oz. Or, mealpowder, 4: nitre, 16; sulphur, 4; brass dust, 1; sawdust, 2¼ oz.; glass dust, 6 drachms. Or, mealpowder, 6; nitre, 1; charcoal, 2 oz.

Silver Rain.—Mealpowder, 2; nitre, 4; sulphur, 2; sulphuret of antimony, 2; Sal-prunella, ½ an oz. Or, nitre, ½ an oz.; sulphur, 2; charcoal, 4 oz.

Note.—Any of the compositions for stars may be used in cases to form rains of different colors—they must not be rammed very hard.

Shower Rockets are such as are charged with a composition which, at the bursting of the rocket, disperses itself in a fiery shower. The heads of the rockets are filled loosely with either of the following compositions, of which the first and the last are the best.

Chinese Fire.—Mealpowder, 1 lb.; sulphur, 2; sulphuret of iron, 2 oz. (Made by throwing iron filings into melted sulphur, stirring them about, and when cold, powdering and sifting them.)

Ancient Fire.—Mealpowder, 1 lb.; charcoal, 2 oz.

Brilliant.—Mealpowder, 1 lb; sulphuret of iron, 4 oz.

Red Shower.—Take deal sawdust and boil it in water in which saltpetre has been dissolved. Take it out, and when dry, spread it out on a table, and sprinkle it with equal parts of mealpowder and sulphur.

Sometimes one rocket is tied to the top of another, when it is called a *towering* rocket; in this case there must only be half a diameter of composition rammed above the piercer of the lower rocket, and a piece of quick match fastened on this, which will communicate the fire to the upper rocket, when it is burnt out of the lower one, carrying it still higher, and a great improvement is made if the lower case be fastened on with the quick match, so that it shall be thrown off as soon as the upper composition burns, as it will thereby be freed from the weight of the empty case.

The Caduceus Rocket, which is represented in Fig. 9, consists of two rockets fastened on the same stick, (which is made thicker than ordinary) by their centre, while their ends are kept apart by a cross slip of wood. They are fired by a quick-match inserted in the end of each,—and when ascending, describe a most beautiful screw of fire.

Honorary Rockets are such as are without a head of stars, rain, &c.; but instead of this have a small case filled with a strong composition—the case should be about 2 ounce in the bore, and 5 or 6 inches long—when charged, stop up the 2 ends tight, either with corks, plugs of wood, clay, or by turning over the ends of the case, and keeping either tight by paper pasted over them. Then drill two holes, one on each side, near the ends, and connect these holes with a quick-match to the top of the rammed composition; the case being first tied tightly on, as represented in Fig. 10.

When fired, the rocket in its ascent will present nothing peculiar, but in descending the fire having by that time inflamed the composition in the upper case, and the holes of this being sideways, the case will revolve on its axis—and thus a beautiful screw of fire will be produced. This case may be made very easily to act when the rocket is yet ascending, if such be thought advisable.

Scroll Rocket.—The principle of boring the case with two holes, one on each side, will show the manner of making that beautiful kind, called the Scroll Rocket: it is made precisely as others, but headed with little cases filled with a quick composition of mealpowder, 4; sulphur, 1; and charcoal, 1 part; closed at both ends, but pierced with the two contrary holes, and these being connected with a quick match, to ensure their lighting properly. When fired each of the little cases whirls round an imaginary axis, producing a most brilliant appearance of so many scrolls of vivid fire.

Line Rocket.—Is merely a common rocket without a bang or report, being tied to a hollow tube of tin or wood, such as a popgun, (seen in Fig. 11.) It is to be suspended by putting a cord through the tube, and firing it at one end of the line, when it will shoot along to the other with amazing rapidity; when here, if there has been a second case attached to it with the mouth in the contrary direction, and a leader to it. the rocket will rush back again with equal force, and so on backwards and forwards as long as there are fresh cases to ignite, and the more rapidly each time, because of the whole machine being lighter as the cases burn empty.

To Fire Rockets.—Nothing is more easy than to fire a rocket. All that is requisite is to place it quite perpendicular, the case of it resting on 2 nails and the stick of it between two others or in a staple—apply fire to the lower end with a portfire sticking on a sharp point at the end of a stick, when the rocket will immediately ascend. If a flight of many rockets is to be sent off at once, a frame work may be made as represented in Fig. 12, and sideways in Fig. 13. The various rockets being connected together with a quick match, that all may ascend at once.

To make a Quick Match.—Take some common cotton such as is used for the wick of candles, and double it so that there may be 4 or 6 strands; boil it for some time in vinegar, and then, when sufficiently cold to handle, draw it through the hands to squeeze out the greater part of the vinegar. This being done, rub over it some common thin paste and afterwards some dry mealpowder, or draw it through the hand loaded with mealpowder, then sift some mealpowder over it and let it dry. Make cases of long strips of paper, the longer the better, and cut about 2 inches wide; rolled on a wire and secured by the outer edge with paste, the quick-match drawn through this when both are quite dry, forms the quick-match, several joints may be united by tying them together with thread and tissue-papering the joints, taking care that the match of one touches the match of the other, or if a great length is required, the match need not be cut at all, but the various lengths of case slipped on by a wire or bodkin, and tied at the joints as before.

Portfires are small thin cases, 2½ inches long and about ¼ inch diameter, (sometimes much larger,) not choked, but merely turned in at one end, and the composition rammed in quite to the other end. They are used in pyrotechnic devices of various kinds, and also attached to long sticks to fire other works. Their composition may be mealpowder, 1; sulphur, 2; nitre, 4; or mealpowder, 3; sulphur, 1; nitre 3. These may be made without cases by rolling string or cotton well in either of the above compositions damped with vinegar or turpentine, though then a small quantity of gum tragacanth should be added. Many persons put a little of this gum to the rocket stars and with good effect.

(To be continued.)

AUTOGRAPHY.

(Resumed from page 239, and concluded.)

The stone used for autography should be polished with pumice-stone, and the impressions will be neat in proportion as the stone is well polished. Autographic work may be executed either cold or warm; that is, taking the stone at its ordinary temperature, or making it warm by placing it near to the fire, or exposing it to the heat of the sun; if the first means of warming be used, care must be taken that the fire be not too hot, or it will crack the stone; the temperature given to it should be about that of an earthen vessel filled with lukewarm water. The work may be done, though less perfectly, without warming the stone. When the stone is thus prepared, it is fixed in the press, and the paper on which the writing is made is applied to it. The

stone may be rubbed with a linen, slightly moistened with spirits of turpentine; and in every case it is necessary that it be made perfectly clean. The turpentine is left to evaporate; and from five to eight minutes before the paper is applied, it is wetted with a sponge and water on the reverse side to that on which the writing is done, so that the moisture may penetrate throughout every part. The water, however, must not appear on the paper when it is about to be laid on the stone; but any superabundance which may remain on it must be removed by a pressed sponge. When the paper is brought to the proper state, it is taken by both hands at once, of its extremities, and placed lightly and gradually upon the stone, so that there may be no plaits formed in it, and it may be equally applied over its whole surface. Care must be taken so to fix the scraper that it may bear steadily on the autographic paper; for if it removes it at all it will change the place of pressure, and the lines will be doubled. There should be at hand five or six sheets of very even paper, so that they may be changed with each impression. The paper on which the writing or drawing is made being placed on the stone, it is covered with a sheet of paper, and subjected to a slight action of the press; then to a second, a third, or even more, until it is believed that the writing is perfectly transferred. At each stroke of the press the paper, which has imbibed moisture, is withdrawn, and a dry sheet substituted in its place. All these operations require to be performed with expedition and dexterity, particularly when the stone is warm, The next thing is to detach the autographic paper, which will be found adhering closely to the stone. To effect this, it is well wetted with a sponge, so that every part of it may be perfectly penetrated by the water; it may then be removed with facility and entirely detached from the writing, which will remain adhering strongly to the stone. If this operation, which requires much practice, be well performed, there will not be found the slightest trace of ink remaining on the paper. Should there be any lines not well marked on the stone, they may be retouched with a pen; or, which is better, with a hair pencil and ink; but when this is done, care must be taken that the stone is quite dry. A part of the sizing of the paper may be dissolved and adhering to the stone; this may be removed by washing or slightly rubbing it with a wet sponge. The stone is then prepared with aquafortis, and the impression taken.

Autography is not confined to the transferring of writings or drawings done with autographic ink; by its means a transfer may be obtained from a sheet of ordinary printed paper, and with such exactness, that it would be impossible, excepting to well-practised eyes, to perceive the least difference between that printed in the usual way, aad that which was the result of the autographic process. This mode is very useful when it is desired to unite oriental characters, which might not be possessed; with words, phrases, or lines composed in ordinary typography. In this way have been executed, in the office of the Count M. C. de Lasterrie, at Paris (from whose papers on this subject, contained in the *Journal des Connaissances Usuelles*, and translated by the learned editor of the *Franklin Journal*, our account of this art is largely indebted,) many pieces in which the French or the Latin language was intermixed with words or phrases in Chinese or Arabic. In the same way have also been executed typographic maps, in which all the details were lithographic, while the names of places were at first produced by typography, and afterwards by autography. The operation is begun by composing and arranging, in a typographic form, the words, the phrases, or the lines, as they ought to stand. The autographic paper is printed on by this form, and the words in the oriental languages are afterwards written in the spaces which had been left for them; the whole is transferred to a stone, which is prepared for the purpose, and from which the impression is taken in the usual manner. The same mode is pursued in making geographical maps. After having printed the names on autographic paper, the other parts of the map, but without the names, are drawn immediately on the stone; and after having printed the names on white paper, the map drawn upon the stone, is printed on this same paper.

Maps, or line engravings on copper, where the work is not very close, may be multiplied in a similar way. For this purpose the plate of copper is covered over with the autographic ink diluted to a convenient consistence. Instead of the autographic ink, a composition is sometimes used, made of one ounce of wax, one ounce of suet, and three ounces of the ink with which the ordinary impressions in lithography are taken. The whole is warmed and mixed well together, and there is a little olive oil added to the composition, if it is not liquid enough to spread itself over the plate; the plate ought to be warmed as usual. After having taken the impression in the rolling press on a sheet of autographic paper, the transfer may be immediately made on the stone, after having rubbed it with a sponge, dipped in turpentine. It is necessary to give three, four, or even more strokes of the press, increasing the pressure at every successive stroke; the other processes, which we have already described, are likewise to be followed. It is well to wait twenty-four hours before *preparing* the stone, in order that it may be better penetrated by the transferring ink; it is then gummed and washed, and is ready for use. This process, which has not yet come much into use amongst lithographers, merits the attention of artists; for it affords the means of re-producing and multiplying geographical charts, and some kinds of engravings indefinitely, so that they might be furnished at a quarter of their present actual value; in fact, all those which are done in lines, or those in which the shadows are boldly executed, are capable of re-producing good impressions by means of autography. The operation becomes extremely difficult when it is necessary to transfer fine line engravings; the lines of these are so delicate, and so near to each other, that they either do not take well on the stone, or are apt to be crushed and confounded together by the effect of the pressure. Much practice and address are necessary to obtain tolerable impressions; and this part of the art requires improvement. In the office of M. de Lasterrie they had succeeded in transferring to stone a small highly-finished engraving, which had been printed on common half-sized paper. After having dry-polished a stone very perfectly, it was warmed, rubbed with spirits of turpentine, and then the engraving was applied to it. This had, however, been previously dipped into water, then covered on the reverse side with turpentine, passed again through the water, so as to remove the superfluous turpentine, and then wiped with unsized paper. In this state the engraving, still damp with the turpentine,

was applied to the stone and submitted to pressure, when it afforded very good impressions; the *preparation* not being applied until it had remained on the stone for twenty-four hours. The difficulties increase, of course, in proportion to the size of the engravings which it is desired to transfer to the stone. Attempts have been made to transfer old engravings; they have, however, succeeded but imperfectly. It would be rendering an essential service to the art to discover a mode of re-producing old engravings by means of autography; the undertaking presents difficulties, but from the attempts made, success does not seem improbable.

CHEMICAL TESTS.

(Resumed from page 224.)

(DETECTION OF METALLIC POISONS.)

Copper.—Copper is the material employed in the fabrication of many culinary vessels: some, however, are tinned; but for the production of specific colors (considered necessary in the science of the kitchen,) the copper vessel is unprotected, in order that the full amount of its poisonous effects may be secured. It is quite evident, on a moment's reflection, that if no other metallic vessels, save those of copper or brass, can communicate the peculiar *green* color to pickles which these impart, it must needs proceed from a dissolution of the copper, in the acid used in pickling; and let it be remembered, that all salts of copper, without exception, are poisonous. *Verdigris* is formed by the action of acetous acid or vinegar, on the copper vessel. So far has this singular ambition carried the *cuisinier*, that even half-pence are directed in some early cookery-books to be boiled up with the pickles to make them "beautifully green." In preserves, the same fatal poison is developed by the use of copper or brass pans, unsecured by tin lining; fruits contain peculiar acids, (the citric, malic, acetic, &c.) which form salts of copper, and become strong poisons. The same thing takes place, where oily or fatty substances are cooked in copper vessels; they contain usually a peculiar acid, called *sebacic acid*, equally formidable in its effects.

It is worthy of remark, that though the vessel contains only a small portion of tinning, as has been shown by the French chemists, it is still preservative; the effect is of an electric or galvanic description; the acid being confined in its action to the tin, and the copper being thus rendered relatively negative, escapes unacted upon. If, for instance, a plate of copper is immersed in dilute nitric acid, it is soon corroded and dissolved; but if a plate of zinc be introduced, the action is completely changed, the zinc is dissolved, and the copper remains unaltered and uninjured. This is the principle on which Sir H. Davy proposed the preservation of copper sheathing on the bottom of ships, which though completely successful in this respect, eventually promoted the attachment of sea weed and marine mollusca. It is clear, therefore, that if we use a *silver* spoon, compared with which, the copper is *positive*, that a poisonous salt of copper must be formed; and even if there should be a partial tinning left on the copper, should a silver spoon be used, it is probable, that a minor quantity of poison would still be elaborated. An *iron* spoon, where there is no tinning, would protect the copper from action, were it never *withdrawn*.

It is not generally known that fatty or acid matter acts more energetically when *cold* than when hot, and this partial suspension is to be ascribed entirely to a *thermo-electric* influence. It is absurd to suppose that if the copper or brass pan be scoured clean and bright, that there is little or no danger, since this makes but a trifling difference; such vessels for culinary purposes ought therefore to be banished for ever from the kitchen.

Copper leaf is the material employed in *gilt* ginger-bread. Sulphate of copper has been fradulently employed to impart an artificial "blue mould" to cheese; and is also added to *writing* ink, the reason why the edge of the pen-knife is so soon lost. Mr. Brande recommended the addition of corrosive sublimate to ink as a preservative! No doubt it would *prevent mouldiness*, but school-boys sometimes do not scruple to quaff a little ink from the pen.

If copper be suspected to be present, the liquid, after being passed through bibulous or blotting paper, should be tested by the following re-agents.—

1. *Ammonia* will produce a beautiful *violet color*, and if carefully dropped on the surface of the liquid, a violet-colored film or stratum will be evolved. A slip of card paper being dipped into ammonia, and subsequently into the liquid, will therefore be tinged violet, if copper be present.
2. Arseniate of potassa will form a delicate *apple-green* tint.
3. Ferro-cyanate of potassa produces a *brown* precipitate.
4. A fragment of phosphorus is coated with metallic copper.

These are the best tests for the detection of copper. It may be added, however, that a rod of bright *iron* will become coated with a film of copper when introduced into a liquid containing any salt of this metal, and pure iron-filings will soon be invested with a film of pure copper, when allowed to remain in the solution.

Corrosive Sublimate, or Permuriate of Mercury.—The tests for discovering this virulent poison are as follow:—

1. Caustic potassa in solution, dropped into the filtered liquid, produces a brick-red or orange precipitate, re-dissolved by nitric acid.
2. Lime-water will produce an effect somewhat similar, though less sensible and delicate, and of a darker hue.
3. Hydriodate of potassa forms a brilliant scarlet.
4. A stick of phosphorus suffered to remain in the solution, will, after some time, be coated with small globules of metallic mercury.
5. A rod of polished iron will produce a phenomenon similar to the preceding, and a ring or coil of bright steel wire will, in due time, reduce the entire muriate, being studded over with minute globules, which may be washed and collected into one.
6. White of egg will be coagulated.
7. A drop of the liquid let fall on gold leaf, will evolve metallic mercury if connected with the gold leaf, by means of an arc of iron wire.

Note.—A drop of ammonia brought in contact with *calomel*, immediately changes it to a *dark grey* color, almost black.

Arsenic.—In incidental poisoning or suicidal acts, this is generally the fatal agent employed, and purchased under pretence of destroying rats and beetles; it is most unwise to vend it under any such pretext,—and nothing can be more irrational than to employ it for such a purpose: children, servants, and other heedless persons, may get hold of it inadvertently. Sometimes it is thrown incautiously into a drawer

or cupboard, where it lies neglected and forgotten, till some new domestic arrangement may call it forth, when it may be only remembered at last, through the unhappy medium of its fatal effects on one of the inmates of the house. In Norfolk, it is used as a bath to steep seed corn in, before sowing, to prevent *blight*, or smut. The *druggist* is scarcely warranted in selling arsenic to any one; and it is a subject of astonishment to many, why it should be suffered to *exist at all* on the shelves of the apothecary, at any rate to be sold to the uninitiated.

In using arsenic for the purpose of destroying rats, mice, or beetles, persons ought to remember that these creatures may, in various ways, introduce the poison into their own food. Besides, it has occurred, that the house has been rendered for some time almost uninhabitable from the putrefaction of the accumulated numbers of rats or mice, thus destroyed. Arsenic may also be introduced into porter, wine, &c., by means of shot-lead, which is frequently though improperly employed in cleansing bottles, and left adhering to the bottom. There have been known cases of this description, where porter had nearly proved fatal to an entire family; and part of a bottle of perry, from a similar cause, was attended with serious effects to myself: shot lead always contains *arsenic*, nor is it attempted to be disguised that *wine-coopers* use a composition containing *arsenic*, to impart an oily-like surface to *white wines*.

1. Add a small portion of potassa to the solution which may be supposed to contain arsenic, and then a little sulphate of copper—a delicate green will be thus formed.

2. Add a few drops of acetic acid, and a little nitrate of silver in solution,—a *yellow* cloud will be formed, and yellow films or strings, commencing at the point of contact, appear on touching the surface of the liquid with a stick of lunar caustic.

4. Ammoniuret of copper, or ammonia-sulphate of copper in solution, added, in like manner, will produce a yellowish cloud. Iodine has also been recommended as a test for arsenic. As alkaline phosphates produce effects somewhat similar on solutions of silver and of copper, the enumerated tests must be always considered secondary, and in a court of justice, are of subordinate weight and validity. The most conclusive evidence is obtained by mixing the powder, collected by picking out, one by one, the white particles, which may be generally accomplished, from its difficult solubility; such particles remaining undissolved among the contents of the stomach, or may be easily detected in the food that remains: these, mixed up with a small portion of powdered charcoal, and introducing into a narrow glass tube, being held over the flame of a spirit-lamp, will soon produce in the superior part of the glass a beautiful ring of sparkling points of metallic arsenic, resembling particles of polished steel, remaining permanently attached for many days.

MISCELLANIES.

The Utility of Phrenology in Wig-Making.—"It has been remarked, in reference to the extensive applicability of the steam engine, that it affords equally the means of forging an anchor and making a needle; and it may be said with equal truth, that the applications of phrenology are not less diversified. This science, we have seen, affords an accurate means of analysing human character, and regulating education and legislation, upon rational principles; and an ingenious individual of this city, Mr. Anderson, has applied it successfully to a more humble purpose, that of the making of wigs. This application of phrenology has been much laughed at, but there is really nothing the least ridiculous in the matter. I understand that all wigs are wrought on blocks of nearly the same form. Now, as the shapes of scarcely two heads are precisely the same, and as the differences in some cases are very great, it is quite evident, that, by such a process, it is impossible for the wig to be accurately adopted to the head of him for whom it is intended. I have visited Mr. Anderson's establishment, and am much pleased with the skill and good sense with which he has surmounted this difficulty. When an organ is large, he makes a corresponding elevation on the block, by means of leather and tinfoil, and having brought the block as nearly as possible to the shape of the person's head, he works the wig upon it, and by this means necessarily succeeds in making a perfect fit. People may laugh at this if they please, but the idea is perfectly sound, and very creditable to the artist's ingenuity."—*Mr. Coombe's Lectures.*

The attention of government has recently been drawn to an important invention for the roofing of buildings, which has been applied with success in the dockyards of Plymouth and Woolwich. It is a description of felt perfectly impervious to all weathers, and requires no other aid to render it efficient as a covering. It has the recommendation of economy, and from the lightness of the material the timbers required for the building may be of a much slighter, and consequently, of a less expensive character. Under tiles, &c., for public buildings and large dwellings, it is becoming very general. It also deadens the noise occasioned by heavy showers of rain or hail upon the roofs of churches, and thus permits the speaker to be audibly heard. From experiments ordered to be carried on at the manufactory in Bunhill-row, it would appear that the "Patent Felt" is applicable to a number of other useful purposes.

QUERIES.

214—What are plants proximately composed of? Oxygen, hydrogen, and carbon, which by their different union produce, sugar, gum, starch, oil, wax, and most other vegetable products In many plants there is also a considerable quantity of nitrogen. Such, for example, those of the cabbage tribe, and fungi, while there are others imbued with ammonia and others with various acids, such as the malic, oxalic, citric, and acetic. While the ashes of all are found loaded with potass if terestrial plants, and soda if marine. There are many other more casual principles. Lime and its salts, flints, &c., are not uncommon.

215—What is the cause of the immense number of insects found in vegetable solutions? Who can tell the origin of life?

216.—What is the reason of the glow worm's light? It appears to be an act of volition in the female animal to attract one of the other sex towards it. The luminous appearance arises from certain glands seated under the skin, and emitting a phosphorescent oil, at a particular season of the animal's existence.

217.—What is the construction, or rather, the method of producing the fire cloud as exhibited at the Polytechnic Institution, London?

218.—Why does putting an empty cup in a pie preserve the juice? Because when the pie becomes hot, the air in the cup becoming expanded by the heat, is forced out below the edge, and when the pie cools, the juice flows upwards to fill the vacuum occasioned by the small portion of hot air remaining becoming cold, and therefore contracting in bulk.

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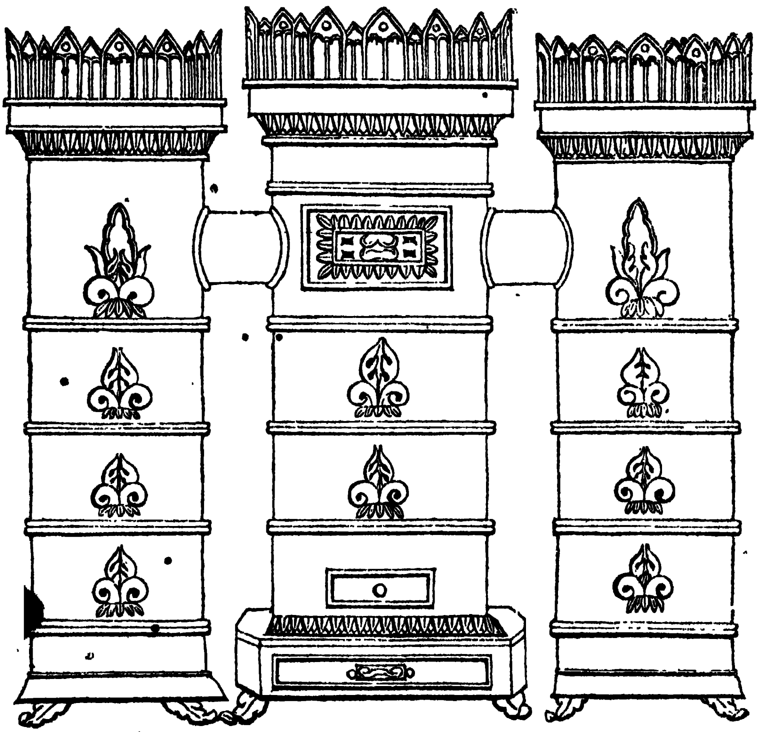
Fig. 1.



PROFESSOR OLMSTED'S PATENT STOVE.

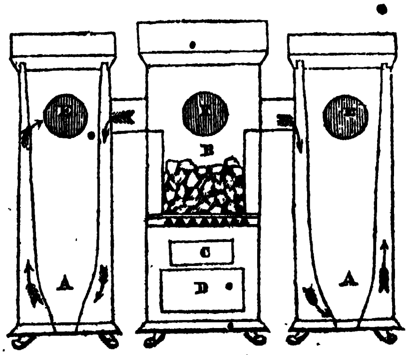


Fig. 2.

PROFESSOR OLMSTED'S PATENT STOVE.

Stoves, by which are understood closed fire-places for the heating of apartments, are of two kinds. First, those which act by radiation, that is, being hot themselves, heat the air in their immediate neighbourhood, and thereby warm the apartment; and second, hot air stoves, or such as have a cavity or chamber surrounding the fire through which the air can pass, and thereby become heated. In this latter description of stove the air enters by some aperture near the bottom, and escapes from the top, being dissipated thence into the apartment. We had intended in the present paper to show the construction and relative merits of several stoves of both kinds now in general use, but are obliged to postpone the subject for a short time, confining our attention at present to the modification proposed by Professor Olmsted, which is represented in our leading cuts, and which appears at first sight to possess some advantages. According to the prospectus issued, it would appear to possess *every* advantage and every perfection that a stove can have; but not to be led away by advertisements, it is requisite to pay some attention to the construction, and so ascertain, as far as reasoning and calculation can ascertain such a matter, how far the apparatus deserves the patronage of the public.

Fig. 1 represents the external view of one of the stoves, and Fig. 2 its internal structure. Of the exterior little or nothing need be said, and the proprietor forms them of various sizes and fashions, to suit the circumstances and wants of his customers. The internal part is extremely simple. The centre of the three pillars is that in which the fire is placed; this is a thin iron case, lined as to the part where the fire is placed with fire brick—in order to equalize the heat the better, this material being a good non-conductor. The part of the cylinder B, therefore, where the fire is, does not become unequally nor yet unduly heated. Thus, as is also the case in Dr. Arnott's stoves, no part becomes red hot, consequently no danger is to be apprehended by contact with any thing around, and also the heated and close smell which usually accompanies hot air stoves is avoided; this peculiar smell arising from particles of animal matter, vapour, dust, &c., which may be mixed with the air of the apartment, becoming burnt and volatilized by contact with a too-greatly heated surface. C is the ventilator to regulate the draught of air to the fire. D the ash-pit. A A are two cylinders, containing each an inner case, open both at top and bottom. These two cylinders are connected by two pipes with the centre, and have also each a chimney near the upper part, represented at E E, which chimneys meet each other behind at F, and afterwards continue in one pipe to any distant outlet. It is to be remarked, that although E E and F in our cut appear to be inserted, the two first into the inner cylinder, and F into the centre cylinder itself, yet this is not the case. E E are inserted into the outer cylinders only, so that the tube A on each side is without any pipe or other outlet, and the centre cylinder has no outlet whatever, except through the side pipes represented. The passage and the effect of the fire is now easily ascertained. The fire is but small, and may be of coke or cinders, so that no flame may issue. The heated air which passes through the fire, makes its exit from the centre cylinder by the pipes connected therewith, and soon fills the space between the outer and inner case of the side cylinders, proceeding round them as represented by the arrows. The draught of air being very little, it is retained here for some time, till at length it escapes by the pipes E E at the back. In consequence of the inner cylinders A A being thus heated, a current of air is produced and flows up the centre, and of course becomes warmed in its passage. Thus the centre of the apparatus acts as a radiating stove, and the side parts as hot air stoves, all supplied by the same fire, and that so small a one, that according to the account of the patentee, from three-farthings worth to a shilling's worth of coke, (according to the size of the apparatus,) is sufficient for twenty-hours' consumption. For the information of our readers it may be requisite to add, that they may see these stoves in use at Stratton, Tucker, & Co.'s, 63, King William Street, and there learn every particular of pattern, price, and management, it being no part of our duty to state these particulars.

PAINTING TRANSPARENCIES.

(Continued from page 237, and concluded.)

3. Any scene which may have been selected for a transparency, may be painted as a moonlight view. The solemn stillness of the subject, however, appears to accord best with a ruin and a sheet of water for displaying the reflections.

In painting a moonlight view of this description, the fine gradations of the atmospheric grey should be carefully blended from the extremities towards the spot where the moon is to be placed. In the case of the paper being very thin, the perfect form of the moon must from the first be preserved clean; while the forms of the floating clouds must be carefully attended to so as to render their appearance natural. On the other hand, when the paper is sufficiently strong to allow of it, the forms of both the moon and the clouds may be *taken out* in proper gradations after the sky has been painted. The same difference of management may be adopted with respect to fluttering streaks of reflection, and the play of broken light on the surface of the water—where it may ripple round a stone, curl up in small waves, or exhibit the changing surface of a current, or the tricklings of a rivulet.

It is most important to remark that, how deep soever the tones of moonlight are, there is no real black; for in all cases where there is no light, direct or reflected, there is always present an aërial medium sufficiently luminous to preclude a genuine black tint, absolutely opaque, and which in a transparent painting cannot, on any account, be admitted.

In the case of the spray or foliage of trees, good opportunity is afforded, in such pieces, for projecting them with characteristic touches on the sky; either to increase a particular effect, or to cover any deficiency or mistake which may have occurred in the management of the sky.

The student should not omit to pay particular attention to impart to the clouds, and to the reflection of the moon upon the water, as natural an appearance as possible. The touches on the water ought to be made bolder and brighter on approaching the front of the picture, in order to preserve the keeping. If the nearest part require its brightness increased, a few delicate touches may be introduced *on the other side of the paper*, taking

care to keep the light subordinate to that given to the moon. A few touches may be given to the margins of the clouds nearest to the moon, to exhibit the reflected light; in which case it is necessary that there be little varnish in the pencil in order to make the touches less powerful in the parts receding to a greater distance from the moon.

When a moonlight view comes to be varnished, the moon may be touched *on both sides of the paper*, in order to obtain a greater degree of brilliancy.

4. The rainbow is a subject well adapted for transparent painting, and may be introduced into any landscape, though some views are better adapted than others to set off its effects. In painting the rainbow itself, it will be requisite to attend to the following directions:—

The sun must be understood to be at the back of the spectator, and it is necessary to recollect that a rainbow is never seen in its highest lustre, except upon a grey cloud. In a painting, consequently, where a rainbow is introduced, each particular ought to be rendered subservient to the principal.

The arch formed by a rainbow is a semicircle, or some other smaller segment of a circle, corresponding to the circumference of the sun, and dependent on the falling particles of rain, which reflect the tints uniformly in the order of red, the outermost color, orange, yellow, green, blue, and violet, the innermost color.

As the effect must depend on the rainbow's being well represented in the scene, it may be advisable to commence by sweeping the arc with a pair of compasses, which will give it much truer than it is possible to effect by the hand alone. The centre of the arch may be placed a little below the horizontal line of the picture; and when the width of the bow has been determined, so as to correspond with the other subjects of the picture, two lines may be swept, within which six varieties of tint have to be introduced.

Tints of carmine, gamboge, and Prussian blue, may now be prepared, and trials made with them for the purpose of ascertaining that each is in accordance with the other in respect of power.

The red tint must be washed in smoothly, so as to occupy one-third of the arc from its upper edge, softening the tint at the sides as the process goes on.

The blue tint should next be washed in on the lower third of the arc, taking care to soften off the edges as in the preceding instance.

The yellow must be laid on the remaining, or middle third, and must have the edges softened off in a similar manner.

If these several softenings off have been managed in a delicate manner, it will be seen, that the yellow tint having been passed over a portion of the red tint above and over an equal part of the blue below it, that a tint of orange is the first, and a tint of green in the second instance, will have been produced. The purity and clearness of these two tints of orange and of green, will depend in a great measure on the correct softening off in the edges of the previous tints.

A tender tint of the red may then be passed along the lower edge of the blue, in order to communicate to it the tint of violet, which completes the colors of the rainbow.

If any difficulty should arise in producing these several tints by a simple application, they may be reduced in power so as not to require being blended on the edges. These reduced tints must, of course, be repeated respectively till the requisite blending into each other be effected.

It must be remembered, that the whole of the expanded rainbow must not be painted with equal brilliancy, as this is an effect never observed in nature, but one part must be much less distinct than another.

When the rainbow itself has been thus painted, the cloudy atmosphere may be washed in, according as the nature of the composition may indicate. The landscape must likewise be painted so as to harmonize with and give characteristic effect to the scene.

In applying the varnish, it may be confined to the more brilliant portion of the rainbow. It will be advisable in this case to take but a small portion of varnish in the pencil, in order that it may be gradually exhausted before approaching the less brilliant portion of the rainbow.

5. The effect of fire-light is peculiarly adapted for transparencies, and is frequently made choice of for this purpose.

If the subject selected be a distant view of Mount Vesuvius, let it be painted expressly to represent the volcano under two different appearances.

For the first, let the mountain be represented as viewed from the sea, or across the bay of Naples under a broad and luminous sky, strongly reflecting on the water in front. A number of vessels may be introduced in the sea view, for the purpose of enriching the scene. The mountain may be represented as retiring in accordance with aërial perspective, while it will be a characteristic feature to have a streak of smoke issuing from the crater, and gradually mingling with the atmosphere.

For the second, in exact agreement with the forms of the first, let another be painted on a separate piece of paper, exhibiting an eruption with flashes of fire exploding from the crater, and bold masses of sulphury clouds rolling away, or partially hiding a brilliant yellow and fiery red centre. The other parts must be subdued with purple or dun-colored tints, so as to give the most striking effect by contrast to the principal subject. This second painting should be done on a slight frame, so that it may be attached to the back of the first.

The varnishing may be confined to the fiery portion of the eruption, to its reflection in the water in the bay, and to such touches of brightness on objects illuminated by the fire-light, according as the effects may be naturally indicated.

In the first or tranquil scene, it will be seen, that the great breadth of light around the mountain and on the water, will admit the colors of the second, or eruptive scene, to appear through with an effect of considerable power.

Any additions to the effect of the eruptive fire must be introduced into the second painting, so that the first may be viewed as a day-light scene, while the second, on being applied, will cause the whole to appear as a night scene.

These five subjects, selected from those most commonly painted in transparency, may furnish the student with hints that he can improve upon or vary as circumstances may require or taste suggest.

Transparencies may be shown to advantage by lamp or candle-light, and may be elegantly adapted to fire screens or hand screens; and in numerous other ways may be rendered interesting and instructive.

ON THE CAUSE OF THE INCREASE OF COLOR BY THE INVERSION OF THE HEAD.

BY SIR DAVID BREWSTER.

It has been long known to all artists and tourists, that the colors of external objects, and particularly of natural scenery, are greatly augmented by viewing them with the head bent down and looking backwards between the feet, that is, by the inversion of the head. The colors of the western sky, and the blue and purple tints of distant mountain scenery, are thus beautifully developed. The position of the head, however, which I have described, is a very inconvenient one; but the effect may be produced, nearly to the same extent, by inverting the head so far as to look at the landscape backwards beneath the thighs or left arm. It is not easy to describe in any precise language, the degree of increase which the colors of natural scenery thus receive; but an idea may be formed of it from the fact that the colors of distant mountains, which appear tame and of a French grey color when viewed with the head erect, appear of a brilliant blue or purple tint with the head inverted. I am not aware of any author, except Sir John Herschel, having attempted to explain this phenomenon. He has, if I rightly recollect, done this in his work 'On Light;' but whether it is in that work or not, I remember well, that he ascribes the increase of the color to the circumstance that the inversion of the head causes the pictures of the colored objects to fall upon a part of the retina not accustomed to the exercise of vision, and therefore less fatigued by the impressions of external objects: in the same manner as when we look long at colored objects, the brilliancy of their color or of any adjacent object is greatly diminished. An incidental observation led me to suspect the accuracy of this explanation, and upon inverting the landscape by reflection, I found that no increase of color took place. I then viewed the inverted landscape with the head inverted, and found the color to be increased as before. Hence, it appears that the increase of color is not owing to the simple inversion of the object, or to our viewing it under unusual circumstances. That the augmentation of tint is not owing, as Sir John Herschel supposes, to the impression falling upon a part of the retina not so much accustomed to receive such impressions, is obvious from the fact that the tint is the same upon whatever part of the retina the image falls; and it is easy to see, that the very same part of the retina is affected, whether we look at an object with the head upwards or downwards, or in any other position, provided we look at it directly. In order to acquire some information on this subject, I requested a friend, who was unacquainted with any theoretical views that had been advanced, to make some observations on the change of color of distant mountains. The result of these was to convince him that the increase of tint arose from the protection of the eye from lateral light, owing to the position of the head when inverted. On submitting the opinion to examination, I found that the tint was not increased by protecting the eye from lateral rays, even to a much greater extent than is done by the inversion or inclination of the head; and, therefore, that this could not be the cause of the increase of color. In this perplexity about the cause of the phenomenon in question, I had an opportunity of observing the great increase of light which took place in an eye in a state of inflammation. This increase was such, that objects seen by the sound eye appeared as if illuminated by twilight, while those seen by the inflamed eye, seemed as if they were illuminated by the direct rays of the sun. All colored objects had the intensity of their colors proportionally augmented; and I was thus led to believe, that the increase of color produced by the partial or total inversion of the head, arose from the increased quantity of blood thrown into the vessels of the eye-ball,—the increased pressure thus produced upon the retina; and from the increased sensibility thus given to the sentient membrane. Subsequent observations have confirmed this opinion, and though I cannot pretend to have demonstrated it, I have no hesitation in expressing it as my conviction, that the apparent increase of tint to which I have referred, is not an optical, but a physiological phenomenon. If this is the case, we are furnished with a principle which may enable us not only to appreciate faint tints, which cannot otherwise be recognized, but to perceive small objects which, with our best telescopes, might be otherwise invisible.

MACHINERY.

The utility of machinery, in its application to manufactures, consists in the addition which it makes to human power, the economy of time, and in the conversion of substances apparently worthless into valuable products. The forces derived from wind, from water, and from steam are so many additions to human power, and the total inanimate force thus obtained in Great Britain (including the commercial and manufacturing) has been calculated, by Dupin, to be equivalent to that of 20,000,000 labourers. Experiments have shown that the force necessary to move a stone on the smoothed floor of its quarry is nearly two-thirds of its weight; on a wooden floor, three-fifths; if soaped, one-sixth; upon rollers on the quarry floor, one thirty-second; on wood, one-fortieth. At each increase of knowledge, and on the contrivance of every new tool, human labour is abridged: the man who contrived rollers quintupled his power over brute matter. The next use of machinery is the economy of time, and this is too apparent to require illustration, and may result either from the increase of force, or from both united. Instances of the production of valuable substances from worthless materials are constantly occurring in all the arts; and though this may appear to be merely the consequence of scientific knowledge, yet it is evident that science cannot exist, nor could its lessons be made productive by application, without machinery. In the history of every science, we find the improvements of its machinery, the invention of instruments, to constitute an important part. The chemist, the astronomer, the husbandman, the painter, the sculptor, is such only by the application of machinery. Applied science in all its forms, and the fine and useful arts, are the triumphs of mind indeed, but gained through the instrumentality of machinery. The difference between a tool and a machine is not capable of very precise distinction, nor is it necessary, in a popular examination of them, to make any distinction. A tool is usually a more simple machine, and generally used by the hand; a machine is a complex tool, a collection of tools, and frequently put in action by inanimate force. All machines are intended either to produce power, or merely to transmit power and execute work.

Of the class of mechanical agents by which motion is transmitted,—the lever, the pulley, the wedge,—it has been demonstrated that no power is gained by their use, however combined. Whatever force is applied to one part, can only be exerted at some other, diminished by friction and other incidental causes; and whatever is gained in the rapidity of execution, is compensated by the necessity of exerting additional force. These two principles should be constantly borne in mind, and teach us to limit our attempts to things which are possible.

1. *Accumulating Power.*—When the work to be done requires more force for its execution than can be generated in the time necessary for its completion, recourse must be had to some mechanical method of preserving and condensing a part of the power exerted previously to the commencement of the process. This is most frequently accomplished by a fly wheel, which is a wheel having a heavy rim, so that the greater part of the weight is near the circumference. It requires great power, applied for some time, to set this in rapid motion, and when moving with considerable velocity, if its force is concentrated on a point, its effects are exceedingly powerful. Another method of accumulating power consists in raising a weight, and then allowing it to fall. A man, with a heavy hammer, may strike repeated blows on the head of a pile without any effect, but a heavy weight, raised by machinery to a greater height, though the blow is less frequently repeated, produces the desired effect.

2. *Regulating Power.*—Uniformity and steadiness in the motion of the machinery are essential both to its success and its duration. The governor, in the steam engine, is a contrivance for this purpose. A vane or fly of little weight, but large surface, is also used. It revolves rapidly, and soon acquires a uniform rate, which it cannot much exceed; because any addition to its velocity produces a greater addition to the resistance of the air. This kind of fly is generally used in small pieces of mechanism, and, unlike the heavy fly, it serves to destroy, instead of to preserve force.

3. *Increase of Velocity.*—Operations requiring a trifling exertion of force may become fatiguing by the rapidity of motion necessary, or a degree of rapidity may be desirable beyond the power of muscular action. Whenever the work itself is light, it becomes necessary to increase the velocity in order to economize time. Thus twisting the fibres of wool by the fingers would be a most tedious operation. In the common spinning-wheel, the velocity of the foot is moderate, but, by a simple contrivance, that of the thread is most rapid. A band, passing round a large wheel, and then round a small spindle, effects this change. This contrivance is a common one in machinery.

4. *Diminution of Velocity.*—This is commonly required for the purpose of overcoming great resistances with small power. Systems of pullies afford an example of this; in the smoke jack, a greater velocity is produced than is required, and it is therefore moderated by transmission through a number of wheels.

5. *Spreading the Action of a Force exerted for a few minutes over a large Time.*—This is one of the most common and useful employments of machinery. The half minute which we spend daily in winding up our watches is an exertion of force which, by the aid of a few wheels, is spread over twenty-four hours. A great number of automata, moved by springs, may be classed under this division.

6. *Saving Time in natural Operations.*—The process of tanning consists in combining the tanning principle with every particle of the skin, which by the ordinary process of soaking it in a solution of the tanning matter requires from six months to two years. By inclosing the solution with the hide in a close vessel, and exhausting the air, the pores of the hide being deprived of air, exert a capillary attraction on the tan, which may be aided by pressure, so that the thickest hides may be tanned in six weeks. The operation of bleaching affords another example.

7. *Exerting Forces too large for human Power.*—When the force of large bodies of men or animals is applied, it becomes difficult to concentrate it simultaneously at a given point. The power of steam, air, or water is employed to overcome resistances which would require a great expense to surmount by animal labour. The twisting of the largest cables, the rolling, hammering, and cutting of large masses of iron, the draining of mines, require enormous exertions of physical force, continued for considerable periods. Other means are used when the force required is great, and the space through which it is to act is small. The hydraulic press can, by the exertion of one man, produce a pressure of 1500 atmospheres.

8. *Executing Operations too delicate for human Touch.*—The same power which twists the stoutest cable, and weaves the coarsest canvas, may be employed to more advantage than human hands, in spinning the gossamer thread of the cotton, and entwining, with fairy fingers, the meshes of the most delicate fabric.

9. *Registering Operations.*—Machinery affords a sure means of remedying the inattention of human agents, by instruments, for instance, for counting the strokes of an engine, or the number of coins struck in a press. The tell-tale, a piece of mechanism connected with a clock in an apartment to which a watchman has not access, reveals whether he has neglected, at any hour of his watch, to pull a string in token of his vigilance.

10. *Economy of Materials.*—The precision with which all operations are executed by machinery, and the exact similarity of the articles made, produce a degree of economy in the consumption of the raw material which is sometimes of great importance. In reducing the trunk of a tree to planks, the axe was formerly used, with the loss of at least half the material. The saw produces thin boards, with a loss of not more than an eighth of the material.

11. *The Identity of the Result.*—Nothing is more remarkable than the perfect similarity of things manufactured by the same tool. If the top of a box is to be made to fit over the lower part, it may be done by gradually advancing the tool of the sliding rest; after this adjustment no additional care is requisite in making a thousand boxes. The same result appears in all the arts of printing; the impressions from the same block, or the same copper-plate, have a similarity which no labour of the hand could produce.

12. *Accuracy of the Work.*—The accuracy with which machinery executes its work is, perhaps, one of its most important advantages. It would hardly be possible for a very skilful workman, with files and polishing substances, to form a perfect cylinder out of a piece of steel. This process, by the aid of the lathe and the sliding rest, is the every

day employment of hundreds of workmen. On these two last advantages of machinery depends the system of copying, by which pictures of the original may be multiplied, and thus almost unlimited pains may be bestowed in producing the model, which shall cost 10,000 times the price of each individual specimen of its perfections. Operations of copying take place, by printing, by casting, by moulding, by stamping, by punching, with elongation, with altered dimensions. A remarkable example of the arts of copying lies before the eye of the reader in these pages. 1. They are copies obtained by printing from stereotype plates. 2. Those plates are obtained (by casting) from moulds formed of plaster of Paris. 3. The moulds are copies obtained by pouring the plaster, in a liquid state, upon the moveable types. 4. The types are copies (by casting) from moulds of copper, called *matrices*. 5. The lower part of the matrices bearing the impressions of the letters or characters are copies (by punching) from steel punches, on which the same characters exist in relief. 6. The cavities in these steel punches, as in the middle of the letters *a*, *b*, &c., are produced from other steel punches in which those parts are in relief.

PREPARATION OF PIGMENTS.

(Resumed from page 222.)

GREENS.

Oxide of Chrome.—This pigment exists perfectly formed in a natural state; but hitherto it has been found in such small quantities that the supply is not sufficient for the demands of art. That commonly used in painting is an artificial production, which is obtained from the decomposition of chromate of mercury by the action of heat. For this purpose the chromate is placed in a small graduated retort, which is filled with it in the proportion of from two-thirds to three-quarters of the vessel's dimensions; this is placed in a reverberatory furnace, to the neck of which a tube is attached, and to the outer end of this tube is fixed a sleeve, or bag of linen, which is plunged into water to facilitate the condensation of the mercury as it volatilizes. By slow degrees the retort is brought to a red heat; the chromate of mercury is then decomposed, and changed into oxygen, mercury, and oxide of chrome; the oxygen disengages itself in the state of gas; the mercury passes across the linen, and condenses; the oxide of chrome remains in the receiver; and, after a strong heat of three-quarters of an hour longer, the operation may be considered complete.

M. Delasaigne has discovered a process more facile and economic than the preceding for producing this oxide of a fine green color, and of a uniform intensity. His method consists in calcining, in a close crucible, and at a red heat, equal parts of chromate of potass and of sulphur; then to wash with lye the greenish mass produced, to dissolve and carry off the sulphate and sulphuret of potass formed by the operation: the oxide of chrome then precipitates, and is obtained pure after many washings. It is not requisite that the chromate of potass should be crystallized, to take from it by these means the oxide of chrome. *M. Delasaigne* has succeeded equally well in producing as fine a color, by calcining with the sulphur produced by the evaporation, given out by the solution of chromate of iron, heated with nitre, and which iron he had previously saturated with the weak sulphuric acid, to precipitate the silex and alumine which are often combined with that metal.

The oxide of chrome is chiefly used in enamel painting. It may be employed in oil; and if this but seldom happen, it must be attributed to the high price of the color, and also because it has not much brilliancy; yet it has more body than any other of the green colors; and this is sometimes an advantage.

Terra Verte, or Green Earth.—This substance, which is found on *Monte Baldo*, in the vicinity of Verona, is an unctuous earth of a pure green tint, which grows darker when mixed with oil. Klaproth, who analyzed it, found that it contained of

Silex	53	parts.
Oxide of iron	28	
Magnesia	2	
Potass	10	
Water	6	
	99	

The green earth of Cyprus, which he has also analyzed, is composed of the same elements, differing little in their proportions. There are other green earths, called by the mineralogists chlorites, which differ from the latter in this respect,—that they contain alumine, but no potass. Green earth is often mixed with veins of brownish or reddish ochre, which, of course, will affect the colors; but there are pieces found of one equal and bright tint; those, therefore, have the preference. Rubens has availed himself much of this color, not in his landscapes only, but also in his carnation tints in his figures of a dead Christ. It is evident that much of the glazing is done with terra verte: it is, in fact, most useful in glazing; because, having only a thin substance, it can be rendered pale by a small portion of white, but in the end it becomes darker by the concentration of its molecules. We see in the greater part of Alexander Veronese's works, for instance his dying Cleopatra, some demi tints, which are too green, and which certainly were not so originally; it, therefore, must be used with great caution. It should be ascertained beforehand, whether a mineral color will, in time, become darker than when first laid on the picture. To ascertain the fact, it is only requisite to put a drop of oil upon one of these colors in their natural state; and if the tone this gives to it should be more intense than that which it acquires by being ground up, it may fairly be concluded that it will attain to the same degree of strength whenever, having completely dried, its molecules shall have re-united as closely as it is possible. Umber, terra sienna, and terra verte, are of this class.

Verdigris.—The acetic acid, (vinegar) and the protoxide of copper combine in several proportions; the only one demanding attention is the above compound, forming the common verdigris of commerce, which is distinguished by the terms French and English, the former of which was for many years considered to be superior to the latter. The present method of preparing verdigris, in this country, is by forming alternate layers of copper plates, and woollen cloth steeped in acetic acid (the pyroligneous is generally employed); after a short time, the plates become corroded by the action of the acid, this is removed and the process repeated, until the plates are dissolved. The French process differs from the preceding by the employment of the stalks

and husks of the grapes after the juice has been expressed, these being moistened with water or thin wine, and kept in a warm temperature, acetous fermentation soon commences; when this has taken place, alternate layers of this fermenting mass and plates of copper are formed, which are afterwards treated in a manner similar to that described above. The verdigris of commerce is frequently adulterated with common chalk colored blue by sulphate of copper. As a pigment it is but little employed at the present day by artists, as but little dependence can be placed upon it.

Crystallized Verdigris, or Acetate of Copper.—This substance is combined of acetous acid and oxide of copper, to which the chemists have given the above appellation. It is prepared by dissolving verdigris in distilled vinegar, evaporating it, and then crystallizing the solution.

The painters, who lived at the time when the arts were restored in Italy, used this color; and Leonardo da Vinci, in his Treatise on Painting, chap. xcix., advises the application of varnish to the surface of the color as soon as it is dry; because, being a soluble salt, it would be carried off whenever the picture was washed. This color, when ground in oil varnish, is not soluble in water, but its only use is in glazing. The bright greens seen in some old pictures are made by glazings of verdigris. Yet it is probable that the ancients knew Scheele's green, the arseniate of copper.

Scheele's Green.—The following process for making this color has been published by its discoverer:—

Dissolve two pounds of sulphate of copper in eleven pints of pure (warm) water, in a copper vessel: then melt separately, also in warm water, two pounds of potass and eleven ounces of white arsenic pulverized; when dissolved, the liquid is to be filtered and changed into another vessel; the warm arsenical solution is then thrown upon the sulphate of copper, adding only a little at a time, stirring it constantly; when properly combined, the mixture is to be left quite still for some hours, and the color is precipitated; the clear liquid is then decanted; upon the residuum some pints of warm water are thrown; this is to be well stirred; it is allowed to settle, and is then decanted; having in this way washed the precipitate three or four times, it must be passed through a filter, and when sufficiently firm it is put into shape and dried upon unsized paper.

The above quantity should produce one pound six ounces of dry color.

By this process, however, we are not certain of obtaining the same shade of color; because the potass of commerce does not always contain the same quantity of alkali. In such a case there would be a waste of either sulphate of copper or of potass and arsenic.

To make the results more certain, and not to lose any of the materials, the acid of arsenic and the sulphate of copper must be combined. For that purpose the arsenic should be reduced to powder and dissolved in a sufficient quantity of water; the solution is then to be mixed with a sufficient quantity of the sulphate of copper, one part of arsenic to ten of sulphate; this will not make any precipitate; some carbonate of soda or of potass is then dissolved; a very small portion of the arsenicated copper is then to be put into a glass, and precipitated by one or other of the two alkalies; the result will show whether the shade of color is that required; if it be too yellow (which it will be if the proportion of ten of arsenic to one hundred of sulphate be exceeded), a fresh solution of pure sulphate of copper is to be added; the operation may be carried on either in a cold or warm state; if the former, the color will be more pale; if carried on to a high temperature, the precipitate will appear like sand, and it then crystallizes; if caustic alkali be used, the color becomes very dark and dries hard; it sometimes happens that this color is required to be of the greatest intensity. Prepared by this method, Scheele's green has a glassy fracture, and is difficult to grind; but if it be soaked in water and afterwards allowed to dry gradually in the air, it will split into small pieces, and then it can be triturated much more readily.

In place of soda or potass, the precipitate may be made with lime water; but it requires a very great quantity to precipitate completely the arsenicated solution, but the precipitate will be equally fine.

Sweinforth and Vienna Green.—For many years past there has been a very brilliant green from copper, known in commerce by the name of Vienna, Brunswick, or Sweinforth green.

M. Broconnot, having analyzed it, has succeeded in preparing it in the following manner:—

Six parts of sulphate of copper are to be dissolved in a small quantity of warm water; then boil six parts of the white oxide of arsenic, and one part of potass; mix this solution by slow degrees with the first, until the effervescence is quite gone off; it soon forms a yellow precipitate, rather dirty, greenish, and very abundant; three parts of acetous acid are then to be added, so as to allow a trifling excess discoverable by the smell; by slow degrees the volume of the precipitate diminishes, and in a few hours it spontaneously forms a deposit at the bottom of the liquor (which is quite discolored) a powder of a fine green color, and slightly crystalline; the floating liquor is then decanted, and the precipitate is carefully washed.

Dr. Liebig has published another process, here subjoined, which gives the same result.

Some distilled vinegar is to be put into a copper saucepan, and, being heated, one part of verdigris is to be dissolved in it; to this is added a watery solution of one part of white oxide of arsenic; these form a precipitate of a dirty green tint, which, for the beauty of the color, must be got rid of; for this purpose an additional quantity of vinegar must be added, until the precipitate is again dissolved; the mixture is then to be boiled; a new precipitate is formed in granular crystals of a beautiful green color; the liquid is then drawn off, and the color carefully washed.

If the floating liquor should still contain an excess of copper, some arsenic is to be added; if only arsenic, then acetate of copper, or if it contains an excess of acetous acid, this will serve to dissolve more verdigris.

Instead of dissolving verdigris in vinegar, crystallized verdigris will do as well, dissolved in water. The color prepared in this way has a blueish shade: if it is required to be more yellow, the arsenic must be increased. It might also be desirable that it should be of a deeper hue: for this purpose a pound of potass must be dissolved in water; add to this ten pounds of the color obtained as above, and heat the whole over a moderate fire. The color will soon be observed to grow darker, and take the required hue; if boiled too long, it comes near the tint of Scheele's green, but always is superior to it in beauty and brightness. The alkaline liquor which remains.

after the operation may be used in preparing Scheele's green.

Brunswick Green.—The two following processes afford two green pigments, which are commonly called Brunswick greens, although they bear no relation to each other chemically.

Into any convenient vessel pour a saturated solution of muriate of ammonia, (sal ammoniac) to which add shreds or filings of metallic copper; cork the vessel securely, and place it in a warm apartment for three or four weeks, during which time a portion of the copper will be converted into a green powder; this when separated from the unoxidized copper, washed and dried, affords one of the best greens of this class.

The other process is simply that of adding to a solution of sulphate of copper, bitartrate of potass, (cream of tartar) stirring the mixture after each addition, until the original blue color of the solution is destroyed, when the precipitate has settled. This, when treated in the usual manner, is an inferior pigment of the above class.

Sap Green.—The pigment sap green is obtained from the juice of unripe buckthorn berries; the expressed juice is strained and evaporated to dryness; it is not unfrequently mixed with alumina to give it body.

(To be continued.)

MISCELLANIES.

Bergamot Oranges.—The Bergamot is a sort of citron, the fruit of which is shorter than that of the common citron. The essential oil contained in the cells of the peel is very odoriferous and agreeable: it is extracted either by pressing the peel between the thumb and finger, over a plate of glass placed sloping; or by distillation with water.

The Italian and French turners are also in the habit of cutting a circle just through the peel, and carefully stripping it off in two hemispheres, turning these inside out and drying them. When dry, they are put on a mould, and their figure being corrected in a lathe, they are used to line globular boxes: the powerful but agreeable scent of the peel is communicated to the substances contained in the box.

Mode of making Sheet Lead in China.—The Chinese in manufacturing the thin sheet lead in which their teas are imported into this country, conduct the operation in an exceeeingly simple manner. The laminæ are not rolled, as from their extreme thinness might be supposed; nor even hammered, as the appearance of the surface might indicate: but actually cast at once in the state in which we see them. Two men are employed; one of them is seated on the floor with a large flat stone before him, with a moveable flat stone at his side. His fellow-workman stands beside him with a crucible containing the melted lead; and having poured a sufficient quantity on the slab, the other lifts the moveable stone, and placing it suddenly on the fluid lead, presses it out into a flat and thin plate, which he instantly removes from the stone. A second quantity of lead is poured on in a similar manner, and a similar plate formed, the process being carried on with singular rapidity. The rough edges of the plates are then cut off, and they are afterwards soldered together for use. Mr. Waddell, a Scotchman, who witnessed the operation in China, applied a similar method with great success in the formation of thin plates of zinc for galvanic purposes.—*Cabinet Cyclopædia.*

Coloring Marble.—The art of coloring marbles so as to give them the richest and most beautiful tints, has been recently carried to great perfection in Italy, by M. Ciceri. A solution of nitrate of silver penetrates into the marble, and produces a deep color. A solution of nitro-muriate of gold penetrates about the twelfth part of an inch: it gives a beautiful violet purple. A solution of verdigris gives a clear green; solutions of dragon's-blood likewise penetrate marble, giving it a beautiful red. It is penetrated to a considerable thickness by all alcoholic tinctures of coloring woods, such as Brazil-wood, Compeachy, &c. The alcoholic tincture of cocheuille; mixed with a little alum, produces a very beautiful bright color, which penetrates far into the marble, and makes it resemble the red marble of Africa. Orpiment dissolved in ammonia quickly dyes marble a yellow color, which becomes more vivid the longer it is exposed to the air. The solvent which causes the coloring matters to penetrate farthest into the marble, is wax. Verdigris, which has been boiled in wax, and applied to marble quite hot, penetrates to the extent of nearly half-an-inch, and produces a fine emerald.—*Birmingham Journal.*

Pelosine.—This substance has lately been extracted by Wiggers from the root of the *Cissampelos Pareira (Pareira brava)*,—a drug which has lately been introduced into the English pharmacopœia. The root is to be cut into small portions and boiled with water acidulated with sulphuric acid, three or four times successively; the decoction is then to be precipitated with carbonate of soda; the brownish grey precipitate is to be washed, dried, and boiled again with acidulated water: the solution treated with animal charcoal, filtered and precipitated with carbonate of soda; the yellow resulting precipitate is to be washed, dried, and treated with ether. This affords pure *pelosine*. It is colorless; when water is added to the solution in ether, a yellow translucid substance is precipitated, which is *pelosine*—free from water. It is uncrystallizable, without smell, sweetish bitter. It is a powerful base, forming salts with sulphuric, muriatic, nitric, acetic, oxalic and tartaric acids, but none of the products crystallize.—*Athenæum.*

Professor Wheatstone, the inventor of the electrical telegraph which is now at work on the Great Western Railway, is at present at Brussels, where he has been trying the new improvements he has introduced in his apparatus. Mr. Wheatstone has succeeded in so simplifying his apparatus, that he has reduced the number of wires employed to two. They are covered with caoutchouc, and inclosed in tubes; the principal thing to be attended to, is to protect them from wet. The great objection which had been previously made to these telegraphs was the difficulty of repairing the wires, in case any should be broken or damaged, as it was supposed it would not be possible to tell where the fracture was. This difficulty has been somewhat obviated by means of a small carriage moved along the line of the telegraph. The place where the defect lies is indicated by a magnetic needle, which changes its position the instant it arrives at the part where the connection is broken. Professor Wheatstone conceives that it is possible to communicate with his apparatus between Dover and Calais. He has been repeating his experiments at the Brussels observatory, in the presence of many scientific men.—*Inventor's Advocate.*

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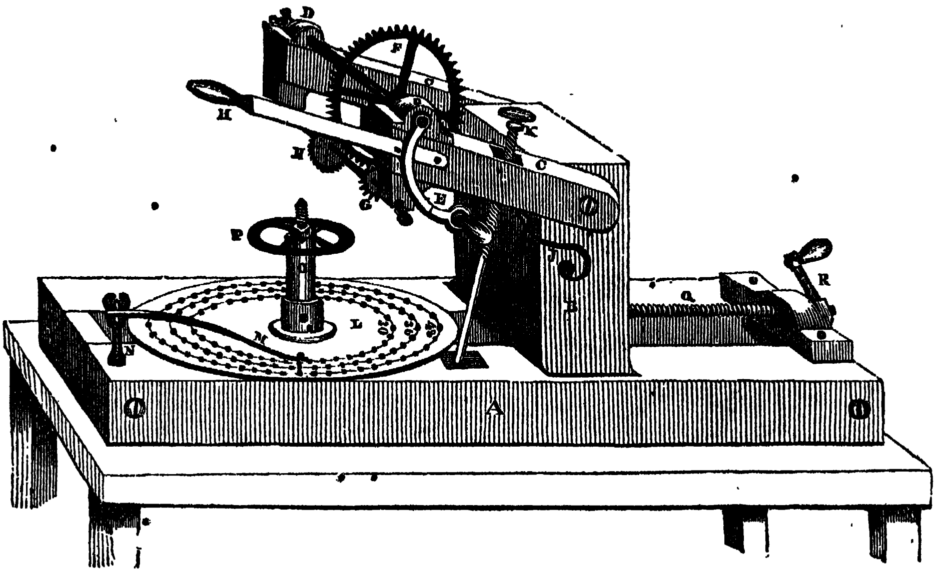
Fig. 1.



CUTTING THE TEETH OF CLOCK WHEELS.

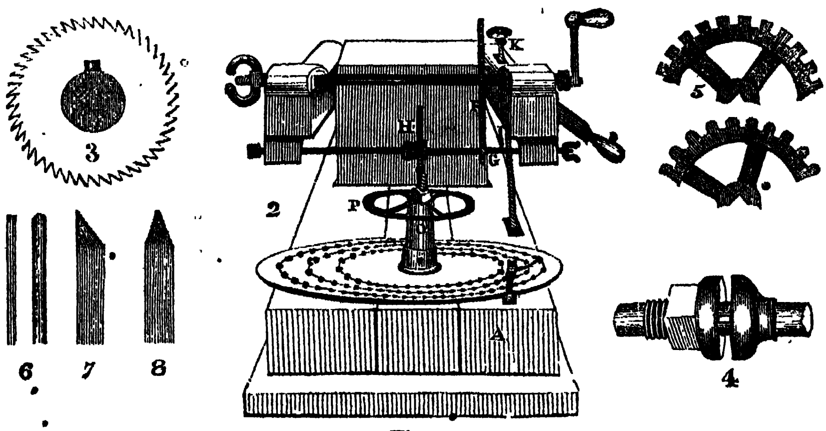


Fig. 2.

CUTTING THE TEETH OF CLOCK WHEELS.

We are not aware of any book whatever, in which is a description of a machine adapted to cut the teeth of small wheels; such, for example, as those belonging to clocks, or such as are adapted to models and other pieces of small machinery; and as wheel-work is so universally wanted, and ready cut wheels, if of any unusual description, so expensive and so difficult to procure, especially by those who reside at places distant from the metropolis, we doubt not that the account of a generally useful machine of this description will meet the wants of numerous amateurs and artizans, into whose hands our work may fall.

Fig. 1 represents the side view of a wheel-cutting machine.

Fig. 2 shows the same machine seen from the end, (the letters are the same in both representations,) also the various parts are in a relative proportion to each other, supposing them made of wood, the size of each, therefore, may be easily obtained—the whole being one-sixth of the size of the machine from which the drawings were taken.

A represents the bed, which consists of two cheeks, exactly similar to the bed of a common lathe. B is an upright block of wood, which is capable of a steady motion between the cheeks—it may have a wedge or other fastening below it, to keep it steady,—when to be set to any particular distance it is moved backwards and forwards by means of the screw Q, which is turned by the handle R. C C represents two arms, fitted to the sides of B by a single bolt, which not being screwed very tight, allows them and all connected with them, a motion up and down, without disturbing B. D D are two pieces of wood screwed upon C C, and so bored as to allow an axis bearing the large wheel F to turn between them—the axis passing through one side and having a shoulder to it near the handle E, and borne on a pivot point at the opposite end. G is a small wheel worked by the large wheel F. The same axis that bears the small wheel G, bears also the cutter H, which cutter is represented of its proper size in Fig. 3,—it is of hardened steel, and bears teeth like those of a saw, but not above half the size shown. It fits on to the axis by means of a nut and screw as seen in Fig. 4. The axis itself is readily taken off by loosening the thumb screw which holds it, it being borne on two pivot points. There is a second H in the first figure attached to a handle,—this handle is, when the machine is in work, to be borne upon with the hand, in order to bring the cutter tightly down upon the work. The spring J is placed so as to bear up the same parts again when the hand is removed from the handle H. K is a screw which is to be adjusted so as to limit the effect of bearing down the handle, that the teeth may be cut all of the same depth.

A second part of the machine is seen beneath. O is a spindle fitting into a socket; the socket itself is merely a bit of wood fixed between the cheeks of the machine, with a round hole in it. The spindle has a shoulder resting on the socket, and moving round with a very steady, equable, and regular motion, and bearing with it the dividing plate L, and the wheel to be cut P. The way in which this last is fixed on is easily seen by the figures. N is an upright stud bearing the spring M, which has a point at the further end. The dividing plate must be graduated with a certain range of circles, so that any particular number of teeth may be cut—for instance, if one circle contains 120 divisions, it will cut wheels of any of the following number:—120, 60, 40, 30, 24, 20, 15, 12, 10, 8, 6, 5, 4, 3, and 2, so also 140 will cut 70, 35, 28, 20, 14, 10, 7, or 5.

To use the above machine, screw on the wheel which is to be cut upon the top of the spindle O. Consider the circle of the dividing plate which is to be used, and fix it by the point of M, at the first mark to be used. Now turn the handle R, so as to withdraw B to its proper distance, which will be seen by bringing the cutter H upon the work, and so as to cut away a small portion, when the handle H is borne down and the winch E is turned round. Thus cut the first tooth carefully to the proper depth, and when cut, turn down the screw K till it meets and rests upon the bed A. K and R are not to be touched any more during the whole operation. To cut a second tooth, turn round the dividing plate the proper distance,—fix M in a new hole, bear upon the handle H and turn E as before. A third, fourth, and all other teeth may be cut in a similar manner.

The teeth of the wheels when first cut will present the appearance of those in Fig. 5—in order to round the corners of them, a second cutter is to be substituted in lieu of the first; this being of the shape necessary and formed like a file, easily polishes the points of the teeth, as by an operation similar to the last they are made to pass one by one under it.

Fig. 6, 7, and 8, show the points of such different cutters, as may be necessary for different purposes.

CREOSOTE

Is the most important of the five new chemical products obtained from wood tar by Dr. Reichenbach. The other four, *paraffine*, *eupione*, *picamar*, and *pittacal*, have hitherto been applied to no use in the arts, and may be regarded at present as mere analytical curiosities.

Creosote may be prepared either from tar or from crude pyrolignious acid. The tar must be distilled till it acquires the consistence of pitch, and at the utmost till it begins to exhale the white vapours of paraffine. The liquor which passes into the receiver divides itself into three strata, a watery one in the middle, between a heavy and a light oil. The lower stratum alone is adapted to the preparation of creosote.

1. The liquor being saturated with carbonate of potash, is to be allowed to settle, and the oily matter which floats at top is to be decanted off. When this oil is distilled, it affords at first, products lighter than water, which are to be rejected; but the heavier oil which follows is to be separated, washed repeatedly by agitation, with fresh portions of dilute phosphoric acid, to free it from ammonia, then left some time at rest, after which it must be washed by water from all traces of acidity, and finally distilled along with a new portion of dilute phosphoric acid, taking care to *cohobate*, or pour back the distilled product repeatedly into the retort.

2. The oily liquid thus rectified is colorless; it contains much *creosote*, but at the same time *eupione*, &c. It must therefore be mixed with potash lye at 1·12 sp. grav., which dissolves the creosote. The eupione floats upon the surface of that solution, and may be decanted off. The alkaline solution is to be

exposed to the air, till it blackens by decomposition of some foreign matter. The potash being then saturated with dilute sulphuric acid, the creosote becomes free, when it may be decanted or syphoned off and distilled.

3. The treatment by potash, sulphuric acid, &c., is to be repeated upon the brownish creosote till it remains colorless, or nearly so, even upon exposure to air. It must be now dissolved in the strongest potash lye, subjected to distillation anew, and lastly, re-distilled with the rejection of the first products which contain much water, retaining only the following, but taking care not to push the process too far.

In operating upon pyrolignious acid, if we dissolve effloresced sulphate of soda in it to saturation, at the temperature of 167° F., the creosote oil will separate and float upon the surface. It is to be decanted, left in repose for some days, during which it will part with a fresh portion of the vinegar and salt. Being now saturated while hot, with carbonate of potash and distilled with water, an oily liquor is obtained, of a pale yellow color. This is to be rectified by phosphoric acid, &c., like the crude product of creosote from tar.

Creosote is apparently composed of 76·2 carbon, 7·8 hydrogen, and 16·0 oxygen, in 100 parts. It is an oily looking liquid, slightly greasy to the touch, void of color, having an acrid burning taste, and capable of corroding the epidermis in a short time. It posesses a penetrating disagreeable smell, like that of highly smoked hams, and when inhaled up the nostrils; causes a flow of tears. Its specific gravity, is 1.0337, at 58° F. Its consistence is similar to that of oil of almonds. It has no action upon the colors, of litmus or turmeric, but communicates to white paper a stain which disappears spontaneously in a few hours, and rapidly by the application of heat.

It boils without decomposition at 398° F., under the average barometric pressure, remains fluid at 16° F., is a non-conductor of electricity, refracts light powerfully, and burns in a lamp with a ruddy smoky flame.

When mixed with water at 58° F. it forms two different combinations, the first being a solution of 1 part of creosote in 400 of water; the second, a combination of 1 part of water with 10 parts of creosote. It unites in all proportions with alcohol, hydric ether, acetic ether, naphtha, eupione, carburet of sulphur, &c.

Creosote dissolves a large quantity of iodine and phosphorus, as also of sulphur with the aid of heat, but it deposits the greater part of them in crystals, on cooling. It combines with potash, soda, ammonia, lime, baryta, and oxide of copper. Oxide of mercury converts creosote into a resinous matter, while itself is reduced to the metallic state. Strong sulphuric and nitric acids decompose it.

Creosote dissolves several salts, particularly the acetates, and the chlorides of calcium and tin; it reduces the nitrate and acetate of silver. It also dissolves indigo blue; a remarkable circumstance. Its action upon animal matters is very interesting. It coagulates albumen, and prevents the putrefaction of butcher's meat and fish. For this purpose these substances must be steeped a quarter of an hour in a weak watery solution of creosote, then drained and hung up in the air to dry. Hence Reichenbach has inferred that it is owing to the presence of creosote, that meat is cured by smoking: but he is not correct in ascribing the effect to the mere coagulation of the albumen, since *fibrine* alone, without creosote, will putrefy in the course of 24 hours, during the heats of summer. It kills plants and small animals. It preserves flour paste unchanged for a long time.

Creosote exists in the tar of beech-wood, to the amount of from 20 to 25 per cent., and in crude pyrolignious acid, to that of 1½.

It ought to be kept in well-stoppered bottles, because when left open, it becomes progressively yellow, brown and thick.

Creosote has considerable power upon the nervous system, and has been applied to the teeth with advantage in odontalgia, as well as to the skin in recent scalds. But its medicinal and surgical virtues have been much exaggerated. Its flesh-preserving quality is rendered of little use, from the difficulty of removing the rank flavor which it imparts.

PRINTING FINE WOOD CUTS.

As the method of printing engravings on wood, here described, applies to what is termed fine printing, it may be as well in the outset to define what is meant by this expression, in its application to this subject.

Fine printing, in this point of view, is the art of obtaining impressions from an engraving on wood, of the surface and the surface only, so as to produce the effect which the artist intended, in the highest state of perfection.

After putting a block on the press, the workman ought to be very gentle in the pull for the first impression, to prevent an accident, which has frequently occurred from thoughtlessness in this particular, by making the pull too hard, and crushing some of the lines; by avoiding this he will be safe, and can proportion his pull to the subject. He should also examine, previous to pulling, that there be nothing on the block—no pins that he may have for his tympan sheet, nor any needle with which he may have been taking out a pick.—Such accidents have happened, and caused great trouble to the engraver, as well as loss of time and disappointment; besides entailing a character of carelessness on the printer.

Neither the pressure nor the impression in an engraving on wood should be uniformly equal: if they be, the effect that is intended to be produced by the artist will fail; and instead of light, middle tint, and shade, an impression will be produced that possesses none of them in perfection; some parts will be too hard and black, and other parts have neither pressure nor color enough, with obscurity and roughness, and without any of the mildness of the middle tint, which ought to pervade great part of an engraving, and on which the eye reposes after viewing the strong lights and the deep shades.

To produce the desired effect, great nicety and patience are required in the pressman; a single thickness of thin India paper, which is the paper I would always recommend to be used as overlays for engravings, is frequently required over very small parts, with the edges of it scraped down, for it is advisable that the overlay should never be cut on the edges, but, even where great delicacy of shape is not required, that it should be torn into the form wanted, which reduces the thickness of the edges, and causes the additional pressure to blend with the surrounding parts.

Particular parts of the impression will frequently come up much too strong, and other parts too weak; it will then be necessary to take out from between the tympans a thickness of paper, and add an additional tympan sheet, cutting away those parts that come off too hard, and scraping down the edges; scraping away half the thickness of a tympan sheet in small parts that require to be a little lightened will improve the impression.

The light parts require little pressure, but the depths should be brought up so as to produce a full and firm impression.

If a block be hollow on the surface, underlaying the hollow part will bring it up better than overlaying it, at least so much that it shall only require a thickness or two of paper as overlays. If a block be too low; it is advisable to underlay it, for the purpose of raising it to the proper height, in preference to making use of overlays, for they act in some measure as blankets, being pressed into the interstices, and rendering the lines thicker than in the engraving.

It will be necessary sometimes, when the surface of the block is very uneven, to tear away parts of the paper in the tympan, to equalise the impression where it is too hard.

The pressman will find it convenient to pull a few impressions while he is making ready, on soiled or damaged India paper, for out of these he can cut overlays to the precise shape and size that is wanted, as he will constantly find it necessary to do so in instances where great accuracy is required in overlaying particular portions; and in these instances he cannot well do without a sharp penknife and a pair of good small scissars. A fine sharp bodkin and a needle or two, to take out picks, are also needful; but he should be particularly careful in so using them as that he did no injury. The best way to avoid this is to draw the bodkin or needle point cautiously in the direction of the lines.

Engravings that are in the vignette form require great attention to keep the edges light and clear, and in general it is necessary to scrape away one or two thicknesses of paper, in order to lighten the impression and keep it clean; for the edges being irregular, and parts, such as small branches of trees, leaves, &c. straggling, for the purpose of giving freedom to the design, they are subject to come off too hard, and are liable to picks, which give great trouble, and are difficult to be kept clear of. Bearers letter-high placed round the block, if they can be applied without the balls touching them, will be found advantageous; if they cannot, pieces of reglet, pasted on the frisket in the usual way, and taking on the furniture, must be substituted, but the high bearer is to be preferred where it can be adopted; these bearers equalise the pressure on the surface of the engraving, and protect the edges from the severity of the pull, which is always injurious to the delicacy of the external lines. They also render the subject more manageable, by enabling the pressman to add to, or diminish, the pressure on particular parts, so as to produce the desired effect.

When great delicacy of impression is demanded in a vignette, it will be found beneficial, after the engraving is beat with ink, to take a small ball without ink, and beat the extremities: this will not only take away any superfluity of ink, but will be a means of preventing picks, and give to the edges lightness and softness, particularly where distances are represented.

If the extremities are engraved much lighter than the central parts, underlays should be pasted on the middle of the block, which will give a firmer impression to those central parts of the subject: it would save trouble to cause the block to be a little on the face, as it would give facility in obtaining a good impression.

When highly finished engravings on wood are worked separately, *woollen* cloth, however fine, should *never* be used for blankets, as it causes too much impression; two thicknesses of stoutish hard smooth paper, in lieu of it, between the tympans is better; sometimes even a piece of glazed pasteboard is used inside the outer tympan. The parchments ought to be in good condition, stretched tight, of a smooth surface, thin, and of regular thickness, so as to enable the pressman to obtain an impression as nearly as possible from the surface only of the engraved lines.

It is indispensably necessary that the balls should be in the best order, the same as for the finest work; and the pressman should be very particular in taking ink, distributing his balls, and beating the block well, otherwise he will not obtain clear, uniform good impressions. If the block be small, and it is worked by itself, he will find that he can take ink more uniformly in small quantities, by first taking ink with a pair of regular sized balls, and distributing, and then taking ink from them to work his cut with; and this more particularly if he be using a pair of small balls. For this work he ought always to have the best ink that can be procured.

A large wood cut left on the press all night is very apt to warp; when this happens, a good method to restore it to its original flatness is to lay it on its face upon the imposing stone, with a few thicknesses of damp paper underneath it, and to place the flat side of a planer upon it, and four or five octavo pages of tied-up letter; in the course of a few hours the block will be restored to its original flatness. This method is preferable to steeping the block in water, which has been frequently practised; for the steeping swells the lines of the engraving, and consequently affects the impression to a much greater extent than this operation. For retaining the original effect, as it came from the hands of the artist, I would carefully prevent the block ever being wet with water, and, when it had been worked in a form with types, would take it out before the form was washed.

To prevent this warping during the dinner hour or the night, turn the tympan down upon the form, run the carriage in, and pulling the bar handle home, fasten it to the near cheek by the catch, where there is one, or else by a chain or rope, or by a stay to the bar from the off-cheek; in iron presses this way is efficacious.

However long a time boxwood may be kept in the log, it will always twist and warp when cut into slices for engraving, on account of fresh surfaces being exposed to the air: large blocks may be restored to their flatness by laying them on a plane surface, with the hollow side downward, without any weight on them, in the course of a night.

When only a few proofs are wanted from an engraving, good impressions may be obtained with little trouble on India paper laid over it, and pulled without the tympan. This observation applies to small cuts, and those of a moderate size; if proofs are wanted from large ones, it will be found advantageous to put the India paper for a few minutes into a heap of damp paper.

A fine engraving on wood should never be brushed over with lye: the best method that I have found in

practice, is to wipe the ink off with a piece of fine woollen cloth damped with spirits of turpentine; and if it should get foul in working, to clean with a softish brush and spirits of turpentine. It will be found in practice that spirits of turpentine take off the ink quicker, and affect the wood less, than any other article used; and the facility with which the block is again brought into a working state, more than compensates for the trifling additional expense incurred, as nothing more is required than to wipe the surface dry, and to pull two or three impressions on dry waste paper.

The engravers always show an impression when the block is taken home to their employer; and this impression is taken in a manner, where the subject is not of a large size, such as to produce a superior effect to what a printer can with a press, when he has a number to do, which are generally worked in a form with types, and his price so low for printing, as not to enable him to do justice to the subjects. This causes great dissatisfaction to his employer, and he is unable to remedy the grievance; for the engraver's proof is obtained by means of a burnisher, with one thickness of paper in addition to that printed on, so that he can examine each part to bring it up where it is required, and leave the others as delicate as he pleases: he thus obtains an impression from the surface only, perfect in all its parts, with the best ink that can be procured; while the printer gives dissatisfaction, because he cannot, in the way of trade, perform impossibilities.

Papillon, in his work on Engraving on Wood, published in 1766, complains of a plan nearly similar being adopted by the French engravers, with which he finds great fault. The following is a translation of the passage:—

'Some engravers on wood have the knack of fabricating the proofs of their engravings far more delicately, and in a more flattering manner than they really ought to be; and this is the means they make use of—they first take off two or three, in order to adjust one of them to their fancy, and which they think will favour their imposition; having selected it, they only beat anew the parts of the block charged with shades and the deeper strokes, in such a manner, that the lighter ones, distances, &c. being only lightly covered with ink, in as far as not being touched in the new beating, they retain no more than what was left by the preceding impression; the result is, that the new proof comes off extremely delicate in those places, and appears pleasing to the eye; but when this block is printed in conjunction with the letterpress, the impressions then appear in their natural state, and totally different from that which they presented on delivery of the work. The strokes are of one equal tint, hard, and devoid of softness, and the distances are often less delicate than the foregrounds. I shall risk little by saying that all the three Le Suers have made use of this trick.'

The pressman will find it an advantage, if it be necessary to do full justice to an engraving, to have a good impression from the engraver, and place it before him as a pattern, and then arrange the overlays, &c., till he produces a facsimile in effect; but the most valuable lesson will be when he can obtain the assistance of the artist at the press side, to direct him in making ready the cut; and I would advise him by no means to be impatient at the tediousness of the operation, as he will obtain more information how to produce a fine impression by this than by any other means. It will also instruct him how to meet the wishes of the draftsman and the engraver, with regard to effect in a way superior to any other; and will, with care and attention, ultimately lead him to excellence in printing engravings on wood.—*Savage's Dictionary of Printing.*

HARDENING OF FILES.

This is the last and most important part of file making. Whatever may be the quality of the steel, or however excellent the workmanship, if it is not well hardened all the labour is lost.

Three things are strictly to be observed in hardening; first, to prepare the file on the surface, so as to prevent it from being oxidated by the atmosphere when the file is red hot, which effect would not only take off the sharpness of the tooth, but render the whole surface so rough that the file would, in a little time, become clogged with the substance it had to work. Secondly, the heat ought to be very uniformly red throughout, and the water in which it is quenched, fresh and cold, for the purpose of giving it the proper degree of hardness. Lastly, the manner of immersion is of great importance, to prevent the files from warping, which in long thin files is very difficult.

The first object is accomplished by laying a substance upon the file, which when it fuses, forms as it were, a varnish upon the surface, defending the metal from the action of the air. Formerly the process consisted in first coating the surface of the file with ale grounds, and then covering it over with pulverised common salt, (muriate of soda.) After this coating became dry, the files were heated red hot, and hardened; after this, the surface was lightly brushed over with the dust of coke, when it appeared white and metallic, as if it had not been heated. This process has lately been improved, at least so far as relates to the economy of the salt, which from the quantity used, and the increased thickness, had become a serious object. Those who use the improved method are now consuming about one-fourth the quantity of salt used in the old method. The process consists in dissolving the salt in water to saturation, which is about three pounds to the gallon, and stiffening it with ale grounds, or with the cheapest kind of flour, such as that of beans, to about the consistence of thick cream. The files require to be dipped only into this substance, and immediately heated and hardened. The grounds or the flour are of no other use, than to give the mass consistence, and by that means to allow a larger quantity of salt to be laid upon the surface. In this method, the salt forms immediately a firm coating. As soon as the water is evaporated, the whole of it becomes fused upon the file. In the old method the dry salt was so loosely attached to the file that the greatest part of it was rubbed off into the fire, and was sublimed up the chimney, without producing any effect.

The carbonaceous matter of the ale grounds is supposed to have some effect in giving hardness to the file, by combining with the steel, and rendering it more highly carbonated. It will be found, however, upon experiment, that vegetable carbon does not combine with iron, with sufficient facility to produce any effect, in the short space of time a file is heating, for the purpose of hardening. Some file makers are in the habit of using the coal of burnt leather, which doubtless produces some effect; but the carbon is generally so ill prepared for the pur-

pose, and the time of its operation so short, as to render the result inconsiderable. Animal carbon, when properly prepared and mixed, with the above hardening composition, is capable of giving hardness to the surface even of an iron file.

This carbonaceous matter may be readily obtained from any of the soft parts of animals or from blood. For this purpose, however, the refuse of shoemakers and curriers is the most convenient. After the volatile parts have been distilled over, from an iron still, a bright shining coal is left behind, which, when reduced to powder, is fit to mix with the salt. Let about equal parts, by bulk, of this powder, and muriate of soda be ground together, and brought to the consistence of cream, by the addition of water. Or mix the powdered carbon with a saturated solution of the salt, till it become of the above consistence. Files which are intended to be very hard, should be covered with this composition, previous to hardening. All files intended to file iron or steel, particularly saw files, should be hardened with the aid of this mixture, in preference to that with the flour or grounds. Indeed, it is probable, that the carbonaceous powder might be used by itself, in point of economy, since the ammonia of hartshorn, obtained by distillation, would be of such value as to render the coal of no expense. By means of this method the files made of iron, which, in itself, is unsusceptible of hardening, acquire a superficial hardness sufficient for any file whatever. Such files may, at the same time, be bent into any form; and, in consequence, are particularly useful for sculptors and die-sinkers.

The next point to be considered is the best method of heating the file for hardening. For this purpose a fire, similar to the common smith's fire, is generally employed. The file is held in a pair of tongs by the tang, and introduced into the fire, consisting of very small coke, pushing it more or less into the fire for the purpose of heating it regularly. It must frequently be withdrawn with the view of observing that it is not too hot in any part. When it is uniformly heated, from the tang to the point, of a cherry red colour, it is fit to quench in the water. At present an oven, formed of fire-bricks, is used for the larger files, into which the blast of the bellows is directed, being open at one end, for the purpose of introducing the files and the fuel. Near to the top of the oven are placed two cross bars, on which a few files are placed, to be partially heating. In the hardening of heavy files, this contrivance affords a considerable saving, in point of time, while it permits them also to be more uniformly and thoroughly heated.

After the file is properly heated for the purpose of hardening, in order to produce the greatest possible hardness, it should be cooled as soon as possible. The most common method of effecting this is by quenching it in the coldest water. Some file-makers have been in the habit of putting different substances in their water, with a view to increase its hardening property. The addition of sulphuric acid to the water was long held a great secret in the hardening of saw files. After all, however, it will be found, that clear spring water, free from animal and vegetable matter, and as cold as possible, is the best calculated for hardening files of every description.

In quenching the files in water, some caution must be observed, All files, except the half-round, should be immersed perpendicularly, as quickly as possible, so that the upper part shall not cool. This management prevents the file from warping. The half-round file must be quenched in the same steady manner; but, at the same time that it is kept perpendicular to the surface of the water, it must be moved a little horizontally, in the direction of the round side, otherwise it will become crooked backwards.

After the files are hardened, they are brushed over with water, and powdered cokes, when the surface becomes perfectly clean and metallic. They ought also to be washed well in two or three clean waters, for the purpose of carrying off all the salt, which, if allowed to remain, will be liable to rust the file. They should moreover be dipped into lime-water, and rapidly dried before the fire, after being oiled with olive oil, containing a little oil of turpentine, while still warm. They are then finished.

APPLICATION OF THE PHYSICO-CHEMICAL SCIENCES TO ARTS AND MANUFACTURES.

BY M. BECQUEREL.

In the rapid whirl which, at the present period, bears along the mental powers—in the midst of our most sober daily concerns—every one wishes to be initiated into the mysteries of natural philosophy, and is eager for discoveries in physics and in chemistry, especially when they promise useful applications to the arts and manufactures. It is to discoveries of this nature that I wish to call your attention: happy if I am enabled to demonstrate to you that the numerous investigations which have given rise to them, may sometimes contribute to the public good: but, before explaining them, permit me to offer a few remarks concerning experiments in general.

Without the art of experimenting, physics, and chemistry, whose alliance has been productive of such great results, could not exist: but since it has been brought to perfection, nothing has been able to arrest their progress: however, to render the study of physics popular, it must be presented free from every obstacle.

When a young man sees, for the first time, the instruments used in the study of physics, the finish of whose ornaments frequently contends with their precision, he should ask himself whether this science may not be cultivated, with the hope of extending its limits, without having at his disposal the means of acquiring similar instruments. This single idea, if he has no other guide than himself, would be sufficient to deter him from devoting himself to a study, for which, before seeing a physical cabinet, he felt a decided inclination. But if he consult the works of the philosophers who have studied, fathomed, and analysed natural phenomena, from Galileo to the present time, he will be convinced that the greatest discoveries, with the exceptions, however, of those which require very accurate measures, have most frequently been made with instruments formed of the first objects which could be procured, and which are always at the disposal of him who knows how to investigate nature. Among a thousand instances I may mention the following:—

Galileo, at the age of eighteen, discovered the isochronism of the oscillations of the pendulum, by observing the periodical and regular motion of a lamp suspended from the roof of the church of Pisa, his native place.

Torricelli discovered the pressure of the atmosphere by means of a glass tube closed at one end, filled with mercury, and reversed in a bath of that metal.

Franklin, in order to establish the identity of lightning with electricity, sent up a kite into the atmosphere.

Volta constructed the most admirable instrument which the physical and chemical sciences possess, with discs of silver, and little round pieces of damp cloth disposed in columns.

Haüy, by the aid of a knife and a kind of coarse compass, was enabled to find the crystalline system of every mineral substance, and consequently its molecular constitution.

Finally, do we apply physics to the study of natural phenomena? Nature herself becomes the laboratory, and we have, as instruments, the various objects profusely diffused over the surface of the globe. By simplifying the means of investigation, the study of physics is rendered less difficult; time is saved, and thus, life is doubled.

In the explanation of works, the same simplicity should be kept up: for history teacheth us that the scientific career of a man frequently is reduced to a few general facts. Detailed works, executed to arrive at these facts, remain laid aside in scientific repertories, and may be compared to scaffoldings erected in order to raise a building, which, the edifice once finished, are pulled down. Hence it is that the scientific life of a man may be summed up in a few words; but these few words express eternal truths, imperishable monuments of the genius which discovered them. Thus, Kepler is known by his three famous laws, the fruit of more than twenty years' labor, and which, in immortalizing him, served Newton as data to find the laws of gravitation, whose action extends all over the universe. It is thus, also, that Newton himself shines forth with brilliant lustre, as having discovered the composition of light, and the laws depending on it; and Volta, as having constructed the pile; that Œrsted acquired great renown by having discovered the action exercised on a magnetic needle by an electric current, and Malus, for the discovery of the polarization of light, by means of reflection.

In order to obtain such great results, which may be expressed in few words, experiments must often be multiplied *ad infinitum*, and a host of detailed facts must be taken into consideration which pass unnoticed in the world.

Such are the general principles which should direct the philosopher in his tedious investigations. I now arrive at less general questions.

Every branch of physics has had its phases of glory, its times of repose, and its recrudescences, which, by turns, have extended its limits. Since nearly half a century, electricity has made rapid progress, and one cannot tell where its discoveries will stop, which are all stamped with the illustrious name of Volta.

In Europe, and, I may even say, in all parts of the world, there is an emulation among all philosophers to extend its dominion, which cannot fail to produce the most beneficial results, as will be seen from the discoveries made within the last few years.

All bodies in nature are formed of homogeneous, or heterogeneous particles, kept at greater or less distances, by the action of forces, the agents of which are found in the spaces which separate them: these forces are, in unorganized bodies, heat, electricity, affinity, and cohesion; and, in organized bodies, those which preside over the phenomena of life, and whose principle escape investigation. It is, therefore, in these intermolecular spaces that the most mysterious, and I may add the most sublime phenomena of nature are operated. If the particles lose their natural position of equilibrium by any cause whatever, there results a host of physical and chemical effects. To study the molecular constitution of bodies, with respect to the forces which govern this constitution, these forces are taken, separated, and put successively in the presence of the material particles, in order to determine the mode of action of each in their mutual relation. It is then recognized, that if electricity be not the first cause of heat and affinities, it is, at least, indispensable to their production, each of these forces being unable to exist without it.

(To be continued.)

FUMIGATING APARTMENTS.

BY PROFESSOR FARADAY.

I WAS called on to direct and superintend the fumigation of the General Penitentiary at Milbank, in doing which some precautions and arrangements suggested themselves, which I have thought might be usefully made known for the information of those who may have occasion to apply disinfecting agents to the purification of buildings, either large or small.

On examining a building to be fumigated, it is necessary to estimate the surface exposed to the infectious vapours, as well as the capacity of the structure. When the air of a place is impregnated with infectious matter, the surface of the walls, &c., will absorb more or less of it in proportion as it is more or less extensive, as it approaches nearer to, or is farther from, the source of infection, and also in some degree according to its nature.

The general arrangement of the Penitentiary was favorable to its complete and perfect fumigation; for, though of great magnitude, yet its division into smaller parts, as galleries, towers, staircases, &c., most of which were glazed, and all of which could be closed by doors, so as to separate them from each other, rendered the successive application of the means employed easy and convenient.

After deciding upon fumigation by chlorine, the next object was to ascertain the most favorable mode of applying it; and I was desirous for many reasons of obtaining a gradual and successive development of the disinfecting agent, rather than a sudden and short one. The latter mode, though it would have filled the building at once, and probably very effectually, yet would seriously have incommoded the operators, and would also soon have disappeared in consequence of absorption by the limed walls, and from dissipation through apertures that would inevitably remain unclosed in different parts of the building: whilst the former mode by continually supplying the disinfecting agent to the atmosphere of the place for a length of time, would enable it better to act on the bedding, clothing, and other articles left in the cells, and allow it also more perfectly to penetrate to every part of the building itself.

The materials used were those generally employed, namely, common salt, oxide of manganese in powder, and oil of vitriol. Upon making experiments with these substances as furnished by the dealer for the fumigation, I found that a mixture of one part

(by weight) of common salt, and one part of the oxide of manganese, when acted upon by two parts of oil of vitriol previously mixed with one part (by weight) of water, and left till cold, produced the best results. Such a mixture made at temperatures of 60° Fahr. liberated no muriatic acid; but in a few minutes began to evolve chlorine, and continued to do so for four days. When examined on the fifth day, and urged by heat, so as to cause the liberation of all the chlorine that could be afforded by it, only a small proportion was obtained. Such a mixture may therefore be considered as having liberated its chlorine gradually but perfectly, without the application of any extraneous heat; and is therefore very proper for extensive fumigation.

The vessels in which the mixture is to be made should be flat, and such as, being economical, are least acted on by the chlorine or acid. Common red pans were used in the Penitentiary; for many being required at once, better earthenware would have been too expensive. They held each about four quarts.

Preparatory to the fumigation, a quantity of the salt was turned out, the lumps broken down by a mallet until the whole was in powder, and then an equal weight of the oxide of manganese added, and the whole well mixed: The acid and water were mixed in a wooden tub, the water being put in first, then about half the acid added, stirring at the same time. When the heat produced had been dissipated, which happened in a few hours, the rest of the acid was added, stirring as before, and the whole left till cold. The men used measures in mixing the acid and water, and were told to take rather less of water than of acid, nine measures to ten being nearly the quantities required. Any slight departure from these proportions would be of no consequence. The pans were then charged, each with about 3½ lbs. of the mixed salt and manganese, and distributed at proper intervals along the galleries, &c., care having been taken previously to close the doors and windows, and to stop with mats or rugs all apertures to which access could be had, especially key-holes, through which there was any draft. The diluted acid being cold, was then carried in cans or jugs, and measured out in the proportion of 4½lbs. to each pan, the mixture being well stirred with a stick, and left to itself. This was done without any inconvenience to the operator, except when the acid was applied too warm: there was abundant time to go from pan to pan, and to close the various galleries in succession. On entering a gallery a few minutes after it had been thus treated, the general diffusion of the chlorine in the atmosphere was sufficiently evident. In half an hour it was often almost impossible to enter, and frequently on looking along the gallery (150 feet in length), the yellow tint of the atmosphere could easily be perceived. Up to the fifth day the odour of the chlorine could generally be observed in the building. After the sixth the pans were removed, though sometimes with difficulty, to be emptied and used elsewhere; and the place fumigated, had its windows and doors thrown open.

It was estimated that the charge of each pan would yield about 1lb. of chlorine, or 5½ cubical feet. The whole quantity of materials used was 700lbs. of common salt, 700lbs. oxide of manganese, and 15lbs. of oil of vitriol. The space requiring fumigation amounted to nearly 2,000,000 cubical feet, and the surface of walls, floors, ceilings, &c., exclusive of furniture, bedding, &c., was about 1,290,000 square feet. This surface was principally stone and brick, most of which had been lime-washed. The space was divided into 72 galleries of 150 feet each in length, and towers, passages, chapel, &c., equivalent to about 13 galleries more. The number of cells, rooms, &c., was nearly 1200.

It was desirable for many reasons that the Penitentiary should be fumigated in the most unexceptionable manner, and the means employed were therefore applied to an extent probably far beyond that required for the destruction of any miasmata that might be within it. The proportion of chlorine evolved to the size and surface of the building may be considered therefore as sufficient for a case of the most excessive kind; and, though the limits are guessed at rather than judged of by any well-founded rule, yet I should consider from one-half to one-fourth of the chlorine as quite sufficient for any of the usual cases where fumigation is required.

MISCELLANIES.

Electrical Clock.—A German artist, now in London, is about to take out a patent for the invention of a clock worked by electricity. The machine, which is remarkable chiefly for its extreme simplicity, is composed only of a pendulum, one large wheel, two escapements, and a quadrature. Such are the visible parts. We must suppose, however, that a pinion and a wheel form the communication between this great wheel and the quadrature, though these are not to be seen. The pendulum at each vibration causes one of the escapements to advance the great wheel one tooth, which after this movement has a pause, making the dead second. As there is no metallic power to set the machine going, we find, on examining, what keeps up the motion—that the pendulum (which is almost out of proportion with the clock) descends into a case, and there, at each vibration, the ball or body, which is furnished with a conductor, approaches alternately two poles, to which voltaic piles supply their portion of electricity, so that the pendulum, when once put in motion, retains it by means of the electricity alternately drawn from the two poles. There can be no doubt that other interesting results may be obtained by employing the electrical fluid as a motive power, however slight the power which such an agent may seem capable of communicating.—*Morning Post.*

Adhesion of Glue.—Mr. Bevan has found that when two cylinders of dry ash, 1½ inches in diameter, were glued together, and after twenty-four hours torn asunder, that 1260lbs. were required for the purpose, and consequently that 715 lbs. were required to overcome the adhesion of one square inch of the glued surfaces. The glue was freshly made, and the season very dry. Much smaller powers were obtained with glue which had been frequently melted, the results being then from 350 to 560 lbs. Upon examining the separated surfaces of the first experiment, the glue appeared to be very thin, and did not entirely cover the wood, hence the estimation must be beneath the truth. From a subsequent experiment on solid glue, Mr. Bevan finds that the cohesion equals 4000 lbs. to the square inch, from which he infers, that the application of this substance as a cement is susceptible of improvement.

The lateral cohesion of dry and seasoned Scotch fir, cut down in 1825, was 562 lbs. per square inch, and that of Memel fir, across the grain, from 540 to 840 lbs.

Fig. 1.

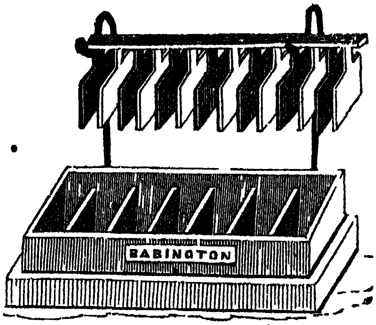


Fig. 2.

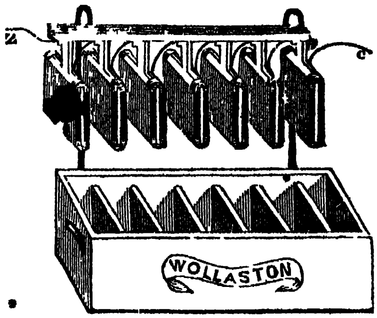
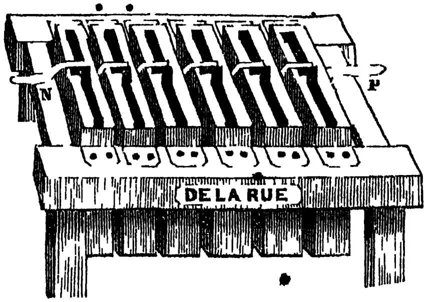


Fig. 3.



GALVANIC APPARATUS—BATTERIES.

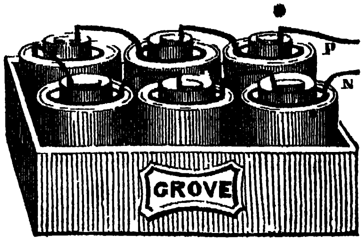


Fig. 4.

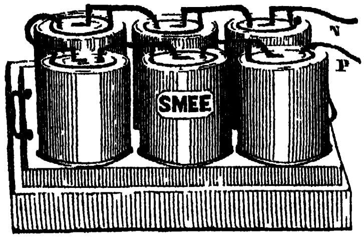


Fig. 5.

GALVANIC APPARATUS.—BATTERIES.

(Resumed from page 98.)

In Nos. LXI. and LXV. we gave figures and descriptions of various galvanic circuits and batteries, proceeding with them in the order of time according to which they were invented. The present week we continue the subject to the more powerful arrangements subsequently formed, that the subject may be rendered complete.

Babington's Battery, (Fig. 1,) is a trough battery, more cumbersome than that of Mr. Cruickshanks, therefore less used than his, though it possesses some considerable advantages, particularly this, that when Mr. Cruickshank's battery is once set in action, it continues that action until the acid is exhausted; gradually decreasing in power from its being first set to work, and although the experimenter may be called away, or may have his attention otherwise abstracted, he has no means of stopping its action for a time, until he may be ready to employ it. Also at the termination of the experiment, he must immediately empty the liquor from the trough, or a useless expenditure of material is the consequence. From these inconveniences Mr. Babington's trough is free. It consists of a square wooden box, divided by partitions of glass. The plates are screwed or soldered together in pairs of copper and zinc, in such a manner that they can be let down into, or taken out of the trough when required, when they may be suspended on hooks prepared for them; another advantage is that the plates may be cleaned when requisite.

Wollaston's Battery, (Fig. 2.) Dr. Wollaston suggested a great improvement in the battery, by surrounding the zinc entirely with copper, or rather placing copper on both sides of it, by which means a very great increase of power was obtained; so superior in efficacy indeed was this arrangement, that until very lately its employment was very general. The lower trough is similar to that of Mr. Babington, or still better is made of earthenware, the partitions being made with the rest of the trough and of the same material, usually divided into 12 cells, for as many pairs of plates. The compound plates are formed thus:—A piece of zinc is cast about a quarter of an inch thick, with a square elbow at top; upon this, at the four corners, are placed four little pieces of wood, to prevent the sheet of copper which passes round it without touching it. The sheet of copper is cut of the same width as the zinc, but about 2 inches more than double of it in length, so that it may be wrapped round the zinc, and soldered the one edge to the other, not touching the zinc any where. A thong of copper also proceeds from this copper case to the plate of zinc belonging to the *next* pair, and so on for the rest—a thong or wire projecting finally from each extreme plate. This collection of elements, like the last described, may be removed from the trough, and returned to it again at pleasure. In all batteries of this description the plates are fastened by means of screws to a piece of baked wood.

Hart's Battery.—Mr. Hart, of Glasgow, suggested a modification of the last battery, by cutting and soldering the copper, so as to form little boxes, capable themselves of holding the fluid. Thus the trough itself might be done away with. This was a great improvement in some respects, but from the circumstance of the plates not being removeable at pleasure, Mr. Hart's battery has been but little used.

All the above batteries were worked by filling them either with salt and water when a very weak action was required, or with acid and water when a more powerful energy was to be exerted. What acid it was better to employ has given rise to much controversy, and even now there is a great diversity of opinion. Sulphuric acid and nitric acid have each their advocates. The former of these, from its rapid action upon the zinc, and decomposition of the water, exerts a powerful energy; but it is not long continued—the cells soon become loaded with oxyde, and with sulphate of zinc, and the galvanic effect ceases. Nitric acid on the contrary occasions a less sudden, and it may be said a less energetic action, but it is longer continued. From a long experience we prefer 1 part nitric, and 2 parts sulphuric acid in every 100 parts of water, or mixed acids about a 30th part—the exact and relative proportions are of little consequence. For electro-magnetic experiments, where an acid battery is used, a stronger solution is requisite; also in lecturing or experimenting for a sudden effect, if the battery be rather weak, a few drops of sulphuric acid dropped into the cells will much aid the experiment.

All acid batteries are temporary in their action, because the acid becomes saturated by one of the metals, and when that is the case it is no longer a sufficient conductor for the fluid; and what is infinitely of more importance, the oxyde produced is at the expense of the water in the trough, that becoming decomposed, and soon offering a serious impediment to a true contact of the acid and metal. By using instead of this a chemical salt, capable of an easy decomposition, this difficulty is got rid of, and the battery works more equally. For example, a battery being charged with sulphate of copper (blue stone or blue vitriol,) the action is kept up by the decomposition of the salt, and not the decomposition of the water. Zinc is oxydated as before, but it absorbs the oxygen from the oxyde of copper contained in the salt, and no hydrogen rises. A consideration of this fact and others, tending to the same end, occasioned those batteries, called sustaining batteries, to be invented; and of which we gave an account in No. XXVIII., to which we are obliged to refer our readers. The next battery, however, is one of the sustaining kind, and therefore we have made the above remarks, nor are they out of place even among batteries of other kinds, for the sustaining batteries are of the utmost value to the really scientific manipulator, notwithstanding the inventions of Mr. Grove and Mr. Smee promise more; but of them hereafter.

De la Rue's Battery is a series of copper cells or square copper boxes, differing very little, if at all, from that spoken of as the invention of Mr. Hart, of Glasgow. Each box contains its zinc plate and the various boxes are arranged along a square frame, and depend from it by lips or shoulders of copper, at the ends of them, as represented in Fig. 3. It is to be filled when in use with a saturated solution of sulphate of copper, and as the decomposition of the salt by degrees renders the solution weaker and weaker, some crystals of the salt must at all times remain in the solution. All other batteries may be worked with this solution, instead of acid and water, and they become thereby constant batteries.

Grove's Battery, (Fig. 4,) we need scarcely allude to, because it is fully described in No. LIV.,

page 13; and the present figure shows the various connections and arrangement. Considering each cup or vessel separately, it is thus constructed:—Outside is a common jelly pot; next withinside this is a cylinder of zinc, (without a bottom;) next is a cup, made of the same shape as the jelly pot, but narrower, and made of a porous substance, such as tobacco-pipe clay, common clay, &c., unglazed—inside of this is a piece of platinum. In the outer part of this arrangement, dilute acid or salt and water is poured, while the inner vessel is filled with strong nitric acid. The action is very powerful for an hour or so, when the nitric acid becomes exhausted, and must be renewed. A very great inconvenience also attends this battery in its present state, and that is the very noxious fumes of nitrous gas which arise from it while in action, and the danger to clothing, furniture, &c., in renewing the acid.

The uninitiated will now perhaps ask three questions, and as we write for such, it becomes us to anticipate them. First—Why is it that this battery acts so powerfully? Secondly—What is the use of the inner vessel? And thirdly—Why must the vessel be porous? We will answer these questions in inverse order. It must be porous, because, were it not so, the galvanic fluid could not circulate from one metal to the other, and which is necessary to form the galvanic current, as explained in former papers. (See No. LXI., Part 14.) The use of the inner vessel is two-fold, first—to separate the different liquids: and, secondly—to prevent the oxide of the metal which is decomposed, from settling upon the other metal, and in those batteries in which a salt is used, this deposit is mostly considerable. The first question, which inquires the reason of the superior power of Mr. Grove's battery, is also easily answered. All metals vary from each other in their galvanic influence, and when any body is decomposed by galvanism, the constituents of that body arrange themselves, or are attracting to particular sides of the apparatus, according to the particular kind of metal of which it consists, for example, if a battery be made of copper and silver, and if water (which consists of oxygen and hydrogen) be decomposed by it, the hydrogen will fly or be attracted to the silver, and the oxygen to the copper—but if a battery be made of zinc and copper, the oxygen will no longer attach itself to the copper, but to the zinc. If a battery be made of zinc and silver the action is still more energetic, because there is a still greater difference between these two metals—one of them (the zinc) very rapidly becoming oxidated, the other (the silver) being acted upon with difficulty; and in all batteries there should be the greatest difference possible between the two metals—and as zinc is more easily acted upon than any other, and platinum acted upon with the greatest difficulty, it follows, of course, that their union will form the strongest battery.

Mr. Smee's Battery.—Not to dwell too long upon a sufficiently-extended article, we will merely refer to Fig. 5, for a representation of Mr. Smee's battery, —and to page 22 of the present volume, for a full description by Mr. Smee himself, as copied from a pamphlet published by that gentleman, and which origin, through an inadvertance, was omitted to be noticed. We would only add to this account that the *silver* plates there recommended, may be made of *wood*, covered with silver-leaf, laid on with gold-size; also that the platinum may be communicated to them by immersing each in a solution of chloride of platinum, or by the electro-type process—in both cases, the platinum, we believe, adheres to the silver very slightly, and more resembling a black powder than a metallic substance; at least this is the result of our own experiments.

If we were asked to recommend any particular battery, or in other words, as to the relative merits of each battery, we should be obliged to give each some particular merit. If the inquirer require a battery for chemical decomposition and to study the laws of the science; the sustaining battery is indispensible, it has no rival in this department. If the inquirer be about to construct locomotive carriages, or require a strong power and little weight, then he would recur to Mr. Smee's. If he required an apparatus but for an hour, for private amusement, he may use either this last, or if the fumes would not be detrimental, Mr. Grove's.

We intended to speak also of a new battery by Mr. Sturgeon, formed of cast iron and zinc, which seems to possess considerable power, but are obliged to defer the account till another opportunity.

GOLD AND SILVER FISH

Belong to the carp tribe, and form the species *Cyprinus Auratus* of Linnæus, being known also under the name of the golden carp, or dorade of China, where they are found in the rivers and fresh lakes. Their singularly splendid color, resides in the membrane immediately beneath the scales, which are subject to singular variations. According to Cuvier, there are three varieties of gold and silver fish; namely, those which are at first blackish, but assume by degrees the golden color, then the silver fish, and lastly those marked by various shades of black, gold, and silver. According to the same author, the accidental changes in the fins and eyes of these fish, arise from the circumstance of their domestication and artificial condition of living. They are chiefly brought to this country from Portugal. Bread crumbs should be sparingly given to them, as it turns the water sour; they will feed on the aquatic plant Lemna, or duck's meat, and also on the small fry of other fish. Hawkins says they should be fed on bread and gentles, with fine gravel sprinkled at the bottom of the globes, changing the water frequently. Others recommend a few millet seeds every three or four days; but the degree of feeding seems to depend on the kind of water supplied, whether hard, or impregnated with vegetable matter, or animalculæ, and also on the frequency of changing it.

In the spring, if small faggot-shaped bundles of twigs of willow, about 8 inches long, be placed in the water, their tendency to vegetate produces an adhesive filmy mucilage, very favorable to the protection and the eventual maturing of the spawn.

On Keeping Gold and Silver Fish.—We have extracted, from the "*Domestic Magazine,*" the following article:—

"Having for three or four years preserved several fish that were presented to us, a few practical hints to those who may be in possession of those foreign beauties, and unskilled in their management, may perhaps be acceptable. The largest globe that London could furnish was provided. New River water, to the extent of three gallons, was given every day; and as the globe was emptied and replenished by means of a syphon, the fish were not disturbed. It is usual to catch the little delicate

creatures, either with the hand, or in a net, in order to remove them, while the water is being changed; but this method, however tenderly managed, terrifies, and sometimes injures them. A frequent cause of their death, is injudicious food, and too much of it; bread kills them, and biscuit is scarcely to be trusted, because the materials of which it is composed are not always pure. Foreign vermicelli, in minute portions, given at intervals of two or three days, is the very best aliment.

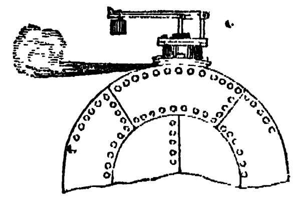
Water contains so much nourishment, that if it be changed every day, little food need be given in addition.

The most proper situation for a globe of fish is near a window (which in fine weather should be open), but not in the *direct rays of the sun*, because the spherical figure of the water, caused by the glass, may tend to form a burning lens. *The centre of a green basket flower stand with exotic plants on each side, is a most elegant arrangement;* at the bottom of the globe two or three shells, and a piece of red coral, may be introduced with admirable effect; they offer a double advantage, for they conceal any unsightliness caused by sediment in the water, &c. I have seen moss introduced, but as it is not an aquatic plant, it might prove distasteful, if not inimical to the fish. When the globe requires to be cleansed, which may be about once a week, it will be requisite to employ a net, in order to remove the fish; this may be made of gauze, attached to a long piece of whalebone, bent round at the end, to form the receptacle, into which *one fish at a time* should be introduced, and lifted gently from the globe into a large bowl."

ELECTRICITY OF HIGH PRESSURE STEAM.

(From the Philosophical Magazine.)

A VERY singular phenomenon, viz. the production of electricity by two steam-boilers, has been observed in this neighbourhood within the last few weeks, the particulars of which I have much pleasure of transmitting to you for publication in your valuable Journal. The boilers in question are situated at Cramlington Colliery, eight miles north-east of Newcastle, where they supply steam to a high-pressure engine of 28-horse power, employed on the waggon-way to haul full and empty waggons to the top of two inclined planes, leading to the Colliery on the one hand, and to the river Tyne on the other. The boilers are cylindrical, with circular ends, each twenty-one feet long, and five feet diameter. They are supplied with water from an adjacent pond by an iron feed-pipe, four inches diameter, and the steam they produce is conveyed to the working cylinder by other iron pipes, six inches diameter, which pipes form also a direct metallic communication between the tops of the boilers. By means of appropriate valves the steam is supplied to the cylinder from one or other boiler at pleasure. A pipe, two inches diameter, leads from the bottom of one boiler on the outside of the brick-work to the ash-pit, through which the sediment deposited by the water is occasionally blown from one of Scott's patent collecting cones, and a similar pipe is attached to the other boiler. The boilers are set in brick-work in the usual way, the fires below, with flues reaching all round, and passing into the chimney also in the usual manner. The flues are covered with large flat bricks, and in the space between the boilers the two flues are necessarily separated by a brick wall. The safety-valves are attached to the boilers by flange joints; and between the flanges, to render them steam-tight, is placed a ring of plaited hemp covered with a cement of litharge, sand, and linseed oil, mixed up together, and when applied of the consistence of glaziers' putty. This cement, as it soon becomes hard, is used about the engine for steam joints which occasionally fail; but all the joints of the pipes are made of iron borings and sal-ammoniac, as is ordinarily employed by engine-wrights. The steam is worked at a pressure of thirty-five pounds per inch.



The joint between the top of one of the boilers and the seat of its safety-valve had given way, and steam was issuing forcibly through this aperture, when on Tuesday, September 29th last, the engine-man, William Patterson, while standing with this current of steam blowing upon his legs, took hold of the weight attached to the lever of the safety-valve, to try the strength of the steam, when he felt a peculiar pricking sensation in the ends of his fingers, but as the steam prevented him from seeing distinctly, he thought he had merely struck his fingers rather suddenly against the weight. On Friday, October 2nd, on taking hold of the lever, he again felt a sensation in his fingers of the same kind as before; and on Saturday, the 3rd, on touching the weight, this sensation was stronger, and more distinct; so much so, as to arrest his attention and lead him to mention it to some other workmen employed about the engine, who all handled the weight, and convinced themselves that there was something about it very unusual. During the time they were thus employed, Patterson applied his finger gently to the lever, and perceived a spark. This was repeated by the whole party, and they soon found that sparks could be obtained from any part of the end of the boiler, as far as the valve upon the steam-pipe connecting the two boilers, and also from the pipe through which the sediment is blown, as already described. They observed further, that while standing in the volume of steam issuing from the joint, and touching the boiler, these sparks were always much stronger than when the boiler was touched by a person not in the current of steam issuing from the joint was very strong, the person exposed to it being probably partially insulated by standing upon the dry and warm brick-work surrounding the boiler, gave strong sparks to others out of the current on bringing his hand to theirs; and once or twice they felt, under these circumstances, something like a slight electrical shock. It may be observed, that at this time the weather was exceedingly fine and dry. It was not long before the engineer of the colliery, Mr. Marshall, became acquainted with these circumstances, and his first feeling was to apprehend that the boiler was in danger of exploding, for, as he said, "when

there was fire on the outside of the boiler, he did not know what there might be within." He accordingly sent to Messrs. Hawks's, of Gateshead, who built the boiler, for a person to examine it, and Mr. Golightly, their manager in that department, went out on Wednesday, the 7th inst., for that purpose. He gave his opinion as to the safety of the boiler, and returned much surprised at the phenomenon it presented. The singular circumstance of a steam-boiler yielding electrical sparks, and giving shocks, now began to be noised abroad; and my friend, Mr. Henry Smith, of Newcastle, who had heard the account both from Mr. Golightly and Mr. Marshall, wrote me a note acquainting me with the matter, and desiring me to go with him to see it, which I did on the 11th inst., and again on the following day, having with us the second time proper electrical apparatus. On our first visit, the boilers being unplugged and empty, we merely satisfied ourselves as to all the particulars of their setting, etc., already detailed. Next day, on our arrival, we found the engine at work, the steam up to a pressure of thirty-five pounds an inch, and blowing off strongly at the joint in the boiler. The day was a little damp, but yet not unfavorable, and we were informed on alighting that the indications of electricity were very faint and weak; however, we proceeded to our examination, of which the following is the result.

1. On touching the boiler with the blunt point of a penknife anywhere about the circular end, the weight or the safety-valve itself, with the steam strongly blowing out of the joint, but with no part of the person exposed to the volume of steam, no spark could be perceived whatever.

2. On immersing one hand in the current of steam, and touching the parts of the boiler already named with the point of a penknife held in the other, a very minute but distinct spark was perceived, and this occurred equally on all parts of the boiler, or safety-valve, within reach.

3. By standing in the current of steam, so as to allow it to blow forcibly upon the person, the spark became larger; it was then one-eighth of an inch long.

4. On holding a large shovel in the current of steam with one hand, and touching the boiler with a penknife held in the other, a spark was obtained three-eighths of an inch long.

5. The cap of a gold-leaf electrometer, the bottom of which was held in the hand, was applied to the weight, the body of the operator being entirely out of the current of steam; and no divergence was produced whatever.

6. The electrometer held in the hand had its cap applied to the weight, the other hand of the operator being immersed in the current of steam; strong divergence was immediately produced.

From this it was evident that the electricity proceeded from the steam; but as the boiler-house was damp, so that insulation by glass could not well be preserved, a copper wire was attached to the shovel already mentioned, the end of which wire terminated in the engine-house, some yards distant from the boiler-house, where was placed a table. The shovel was held by Mr. Smith in the current of steam, with its edge about an inch and a half from the aperture through which the steam issued, and the wire leading away from the shovel was insulated by being attached to sticks of sealing wax held by assistants. Mr. Smith stood on an insulating stool.

7. On touching a pith-ball electrometer, the threads of which were five inches long with the insulated wire leading from the shovel held as mentioned, the balls diverged four inches with positive electricity.

8. The wire was attached to an insulated tin conductor, when it yielded sparks half an inch in length.

9. A pointed wire attached to this conductor exhibited the brush of light a quarter of an inch long, which always attends the escape of positive electricity from a point into the air.

10. A small jar was now charged so strongly as to give a rather disagreeable shock. By this time a large crowd of men, women, and boys from the "Pit Raw," or pitmen's residences near the colliery, attracted by the novelty and singularity of the circumstances, had gathered about us, filling the engine-house and looking on with great curiosity and interest. A circle of sixteen of these men and women was formed, and they received together, much to their surprise and merriment, a powerful shock from the charged jar. This was several times repeated, the numbers receiving the shock varying each time from twelve to twenty.

11. A stout card was perforated by a discharge of the jar; and cotton wrapped round the end of a copper wire and dipped in pounded resin, readily set on fire.

12. When the edge of the shovel was made to approach the aperture through which the steam issued as near as three-quarters of an inch, very vivid and bright sparks of that length passed continually between it and the boiler.

13. The second boiler did not discharge steam through any fissure, but on lifting its valve by the hand it blew off in a strong current. When the shovel was held in one hand in this current of steam issuing from the safety-valve, and the boiler was touched with a penknife held in the other, a spark passed exactly, as under the same circumstances in the boiler subjected to the above experiments.

From this it would appear that the steam of both boilers was in the same electrical condition.

During the whole of these experiments the engine was doing its work as usual, occasionally going and occasionally standing; but no difference was observed in the electricity given off by the steam.

I have been most careful to supply an exact account of the facts of this extraordinary, and, as far as I know, unprecedented case, but I do not offer any theory to account for the phenomena. It is hardly possible to suppose that there is any local peculiarity about these boilers, or the place where they are situated, to occasion the highly electrical condition of the steam which is produced in them; and yet it is as difficult to suppose the fact of high-pressure steam being electrical a general one; for if it were so, it could hardly, up to this time, have escaped observation. The conditions, therefore, under which steam becomes electrical require to be investigated, and it is not unlikely that the investigation may lead to important results.

H. L. PATTINSON.

Bentham Grove, Gateshead.

COMPOSITION ORNAMENT MAKING.

The first employment of the composition which is now used for making picture-frame ornaments, was for ornaments for chimney-pieces. In houses built about sixty or eighty years ago, we frequently see

the chimney-pieces decked with laurel leaves, beading, oak leaves, Cupids, flying angels, Fame blowing a trumpet, &c. These are, in general, made of the composition of which we are now speaking, and were the first purposes to which it was applied.

The principal ingredients in this composition are glue, water, linseed oil, resin, and whiting, which are combined in such proportions as to make a mixture soft enough for working, while, at the same time, it should be so tough as not to crack, and should harden in a few hours if the ornament be thin, or in a day or two if it be more massive. The state in which it is used by the ornament maker is that of a stiff dough; and the making of it is not much unlike the process by which the baker makes his dough. The proper amount of glue is steeped in water, which is heated to dissolve the glue; while the other ingredients—oil, resin, &c.—are melted in a separate vessel, and then poured into the vessel containing the melted glue. The whiting is pounded, and placed in a tub or pan—being previously warmed if the weather be damp and cold—and the hot melted glue, &c., is poured upon the whiting, and then well mixed up with it, and kneaded, rolled, and beat, until it becomes a smooth, tough, elastic kind of dough or putty. It may then either be used at once, or may be laid aside for future use; but, whenever it is used, it must be warmed, either before a fire or by admitting steam to act upon it, because, when cold, it is too hard and stiff for use.

The manner of using this composition is to press it into moulds; the preparation of which is by far the most important part of the composition ornament maker's business: indeed, it is generally done by men who are not engaged in making the ornaments themselves. The moulds are, in most cases, made of box-wood, which, by its smoothness of grain, admits very fine figures to be cut in it, and, by its hardness, is very durable. The mould carver has to proceed with his work just in an opposite way to the common carver; for he must make depressions or hollows instead of raised projections, and projections instead of hollows. An engraver must make all his figures left-handed on his engraved plate, if he wants them to appear right-handed on the printed copy of the plate: so, likewise, must the mould carver make his mould look, in every part, directly the reverse of what he wishes the ornament to appear.

The block of wood being planed and smoothed, the carver draws on its surface a representation of the object which he wishes to carve, and then proceeds to work out the minute details. The tools used in this sort of carving are exceedingly fine and sharp, some of them not exceeding one-twentieth of an inch in width. They are, as in common carving, mostly gouges, with various degrees of curvature. The sharpening of them is a matter of great nicety, and in some cases requires files made of very fine wire.

The block of box-wood is moistened with oil during the process of cutting, in order to facilitate the progress of the tool. The cuts are, in the first instance, made perpendicularly from the surface of the wood, and afterwards varied into the necessary directions to produce the pattern. In order to know how to vary the depth of different parts of the mould, the carver must either be guided by the accuracy of his eye and the correctness of his taste, or he must have another mould of the same pattern before him.

Sometimes moulds are made by casting, the material being brass, copper, pewter, lead, or sulphur (plaster of Paris being too easily broken). A model, representing the object which it is desired to produce, is made of composition or plaster, and is placed on a flat stone, and surrounded by a raised border or edging, so that it lies in a cell or trough. The model is then oiled, and the melted metal or sulphur is poured on it, so as to entirely cover it. When cold, the raised border is broken away, the mould taken up, and the model removed from within it. It is then imbedded in a wooden case to preserve it from injury, and to fit it for the better reception of the composition. Sometimes brass moulds are made in this way, and afterwards *chased*; that is, the minuter details of ornament are cut, or rather scratched, by very fine tools.

When the mould, whether of wood, metal, or sulphur, is to be employed to cast ornaments, it is brushed over with oil, to prevent the adhesion of the composition. A piece of composition, large enough for the intended purpose, is then taken up in a warm soft state, and pressed into the mould by the hand. A wet board is then laid upon the surface of the composition, and the whole is put into a powerful screw-press, by which the composition is pressed into every part of the mould, however deep and minute it may be. The same pressure makes the upper surface of the composition adhere to the wetted board, so that, when it is taken out of the press, the mould may be pulled off the ornament, leaving the latter adhering to the board. When the cast has become a little hardened, it is cut, or rather sliced off, with a broad knife, to the required thickness.

The composition ornament, thus made, is exceedingly pliant and supple, and may be bent into almost any form without breaking or injuring it: it is this property which makes these ornaments so convenient; since they may be applied to the round, the flat, or the hollow parts of a frame, with almost equal ease. They are fixed on either with glue, or, if quite soft and warm, with hot water, which, by softening the glue contained in the composition, produces a sufficiently strong cement; and, in a short time, they become sufficiently firm and hard to be handled without injury.

In those modern frames which are intended to imitate antique carved frames, the manner of laying on the various pieces of ornament requires much care in the workman. If an antique frame, or a drawing from it, be given to the ornament maker to imitate, he must have moulds carved of all the various parts, so that when united on the frame, the assemblage of composition casts may present a facsimile of the frame. If he be required to produce a frame, or if he wishes to do so on speculation, which shall possess a general resemblance to old patterns, but without tying himself down to any individual pattern, he has a demand on his taste and judgment, both in the cutting of moulds and in the disposition of the various pieces of ornament on a frame. A drawing or a copy may assist, but some degree of natural taste is almost indispensable in this part of the business.

This composition, being a compact substance, is heavy,—so much so, that on some large frames the weight of composition is as much as 200 lbs. This is a point in which carved ornaments have a great superiority over composition; indeed, the heaviness of the latter was one reason which led to the adoption of *papier machée* ornaments.

When *papier-machée* ornaments are used, they are cast in moulds greatly resembling those of which we have lately spoken. The paper is in the state of a pulp; but there is this difference between the two kinds of ornaments. The *papier* pulp is pressed between two moulds, so that the thickness of the ornaments is seldom more than about a quarter of an inch at any part; this is attended with two advantages, viz. the ornament is of less weight, and there is a saving of material. These ornaments are much lighter than those made of composition, and will bear a blow or a fall without so much liability of fracture. Still, however, they are not much employed by the carver and gilder, as the substance of which they are formed does not form so good a foundation for gold as is afforded by wood or composition. *Papier-machée* ornaments are much employed in the decoration of large buildings, such as theatres, &c. The ornaments in the new House of Lords are of this material.

APPLICATION OF THE PHYSICO-CHEMICAL SCIENCES TO ARTS AND MANUFACTURES.

BY M. BECQUEREL.

(Resumed from page 263.)

EXPERIMENTS based on the velocity of electricity —a velocity of 90,000 leagues per second, and greater than that of light—tend to prove the quantity of electricity associated with the particles of bodies is so enormous, that the imagination is startled at it. The elements of a simple particle of water appear to contain, according to the calculations of a celebrated natural philosopher, 800,000 charges of an electric battery composed of eight equal troughs, of two decimetres in height and six in circumference, and obtained with thirty turns of a powerful electric machine. If the quantity of electricity which is accumulated in the elements of a single particle of water were suddenly to become free, the most terrific detonations would be heard, which would shatter the edifice to atoms. In fact, this power, compared with which steam is nothing, whether it be considered as a very subtile matter, or as the result of a vibratory motion of the air, is uniformly employed by nature in maintaining the combinations and molecular constitution of bodies. The efforts of natural philosophers, therefore, ought to tend, as indeed they do daily tend, to withdraw this force from the bodies which contain it, in order to apply it to the sciences and arts. As yet we have been able to liberate only a very small portion, which, nevertheless, produces chemical, calorific, or mechanical actions of great intensity. What, then, will it be when we are completely masters of it?

This force is liberated in all chemical actions, even the weakest, as heat in combustion and in all molecular phenomena; but, as heat is rendered available in chemical operations, so also should we turn to account the electricity disengaged, in order to provoke affinities where they are not manifested, to give them, when required, new energy, to transport bodies into different media, and to produce calorific effects even superior to those which we are able to obtain with our furnaces. Such should be the object of electro-chemistry. As an application of the calorific effects of this power, I may mention the following example:—

A platinum wire, communicating with the two extremities of a voltaic apparatus with a uniform current, becomes incandescent for some portion of its length. If this part be spirally twisted, all the heat is then concentrated in the interior of circumvolutions. If small crucibles, with thin sides, made of a refractory earth, be placed on it, the greatest imaginable effects of fusion are produced, since the platinum itself may be fused: the eye can scarcely support the light given out: assays of gold or silver ores of several decigrammes are effected in two or three minutes, to liquefaction and cupellation; the combustion of the diamond is operated in a few instants. This is not all; even this helix may be put under an exhausted bell-receiver, into which may be introduced all the gases with which we mean to operate, so as to fulfil conditions which the chemist has not always the possibility of combining.

The thermo-electrical instruments some years ago employed to determine the interior temperature of the body of man and of animals, have again been used for the same kind of investigation, and particularly for studying the instantaneous calorific changes which the organs experience in various pathological cases, or under determined physiological circumstances, and which cannot be appreciated by ordinary thermometers: they have also served for ascertaining that vegetables have a heat of their own, although very different from that of the ambient media; that this heat is inappreciable during the night on account of the sleep of plants, and that it again shows itself under the influence of light, whilst the heat of the buds and flowers remains during the night.

The electrical forces, acting chemically, furnish us with the means of studying the influence of masses in the phenomena depending on affinities (a subject which greatly occupied philosophers at the commencement of this century), and to measure these affinities under various circumstances.

In a combination of two atoms, the two atoms are united to one another by virtue of a force called *affinity*, whose nature is unknown to us, and which varies in intensity according to temperature and various physical causes. Now, if, with an exceedingly delicate instrument, we could lay hold of each of those atoms, and pull them in a direction contrary to their reciprocal attraction, the force employed to conquer the effect of this attraction might serve as a measure of it. Instead of this ideal apparatus, we have, in electric currents, a power capable of fulfilling the same functions. From the facts observed, it results that when two salts of the same acid are dissolved in water, we have an accurate means of determining the relation between the affinity of the acid for each of the two bases, and of following, step by step, the variations which this relation undergoes as that of the saline bases changes. The law of masses which fetters all these relations allows two metals, or any two substances in solution, to be separated from one another without recourse being had to the ordinary chemical means.

There are few phenomena in the production of which electricity does not participate: phosphorescence is of this number. Recent observations on the property which certain bodies possess of becoming luminous in the dark, under the influence of various causes, reveal to us, in the electrical light, a new faculty. It is known that the solar spectrum resulting from the decomposition of light by the

prism is composed of various parts which possess, some the calorific, others the chemical faculty. It is also known that light renders various bodies phosphorescent, which have been exposed to its action for a few instants, and that all parts of the spectrum do not possess this faculty in the same degree. The observations in question show that different substances, such as glass, gypsum, &c., which allow of the passage of light entirely, or without sensible diminution, may partially or even totally remove from it the power of rendering bodies phosphorescent. Thus, this power is perfectly distinct from that which a focus of light possesses of lighting or heating bodies; light probably has yet many other properties which may one day be discovered.

Such now is the delicacy of our instruments, that we can study the chemical changes of light in circumstances under which formerly they could not be recognized.

Works on the application of electro-chemical force to the metallurgy of silver, copper and lead, without the intervention of mercury, employing but little fuel, or even none at all in many cases, have been successfully continued on considerable quantities of ore procured from different parts of Europe, Asia and America. The researches have been carried on—1st, in the immediate separation of metals from each other, particularly of silver from lead, in galena; an operation so rapid that two kilogrammes of silver may be extracted, in the metallic state, from a silver ore, properly so called: 2ndly, in the preparation to which the ore is subjected, in order to dispose of each metal to be removed by the electric current,—a preparation which, varying according to the nature of the ore, does not present any difficulty when the silver exists in it in the metallic state, or as a sulphuret, as is most frequently the case with that from Peru and Mexico, whilst it is more complicated when the silver is in combination with other substances, the employment of small quantities of fuel then becoming indispensable for effecting roasting at a low temperature.

In those rich countries it frequently occurs that the ores are abandoned, either for want of the fuel required for smelting them, or preparing them for amalgamation, or on account of the distance from the sea, at which they are found, which is unfavorable to their removal to Europe, where they might advantageously be treated.

In Columbia, where considerable quantities of very zinciferous gold and silver ores are found, the richest are sometimes exported to Europe to be smelted, whilst the poorest, and those of an average quality are abandoned, or treated with so little advantage that the companies are losers by it. They are now endeavouring to introduce new means of preparation which apply as well to amalgamation as to the electro-chemical process; we are therefore led to think that this process will very soon be put in practice, if not entirely, at least to a great extent, in those countries of both divisions of America, which possess the requisites,—abundance of sea-salt, and in some cases, a little fuel.

The silver ores, which most resist amalgamation, and other modes of treatment, are those which contain much copper or arsenic. The quantity of these ores is very considerable, particularly in Chili, which the inhabitants offer to the Europeans, who sometimes, for want of freight, take them as ballast, without being certain of deriving any advantage from them in consequence of their ignorance of their contents and of the mode of treating them. Sometimes also it happens (and that has very recently been seen) that the Europeans get ores whose richness in silver and copper is sufficient to defray the expense of freight and treatment. It is therefore necessary to separate from these ores, in Europe, and at small cost, the silver, copper, and arsenic. This problem has just been solved in a very satisfactory manner, presenting advantages to speculators who are more enlightened than their predecessors.

In studying the cause of the working of these mines in America being given up, it will be found that it must be attributed, not only to the difficulty of heating certain ores, but also to the price of mercury, which is so high, that, in Mexico and Peru, small works have been constrained to stop; and, moreover, to the difficulty of getting rid of the water which inundates the mines. The latter obstacle often causes considerable injury to the European companies established in the New World. These inconveniences, serious as they may be, are not insurmountable: to conquer them, stability is required in the social state of each country, and that the arts and sciences encouraged in them should be universally diffused.

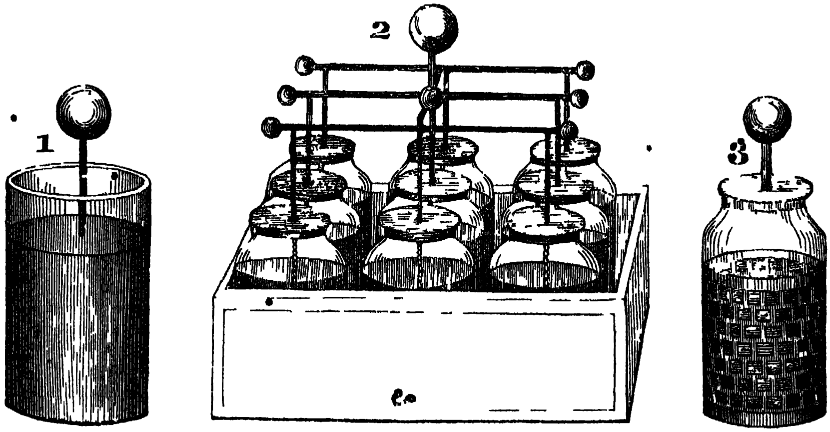
It is not the same in Asia, in the Russian possessions, where great mineral riches exist, from which great profits are daily being derived, owing to the gradual and judicious introduction of improvements made in Europe in the treatment of the precious metals, from which immense advantages will accrue to the Russian empire.

In the silver mines of Altaïa, which belong to the emperor, and whose produce is very considerable, the working is directed with method and economy. The expenses of extraction, of treatment and management do not amount to more than a fourth of the rough product, notwithstanding that the ores are generally very poor. These advantages are owing to the very low price of hand labor, to the abundance of fuel and substances necessary for smelting,—advantages not generally met with in America,—where the price of the daily labor of a miner is ten times as high, and where fuel is wanting, especially in Mexico, and in the Cordilleros, on account of the elevation of the mines above the level of the sea.

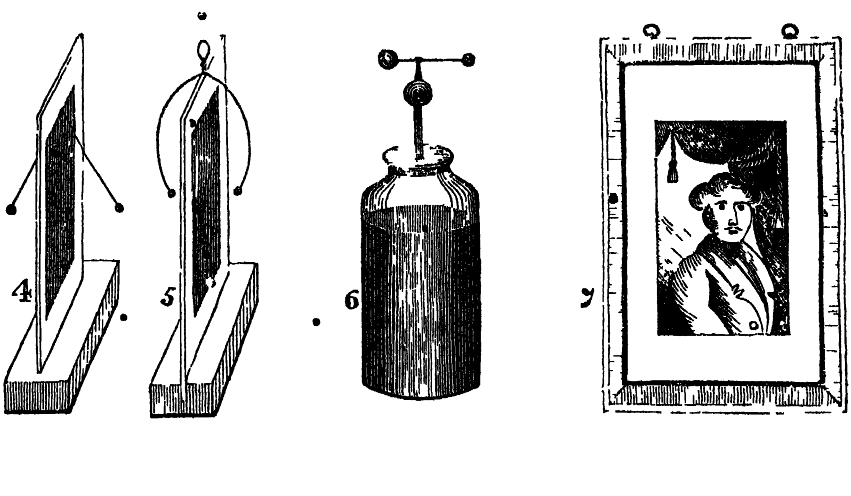
Although the electro-chemical treatment perfectly applies to the ores of Altaïa, and has recently been proved by a very considerable quantity submitted to this process, yet it must not be dissembled that in countries where fuel is abundant, and sea-salt rare, fusion will always be preferable, except in the case of complex ores, which are often a stumbling-block to metallurgists.

Silver mines are not very numerous in Russia: the only important ones are those of Altaïa and Nertchinsk. A few exploitations in the Caucasus and the Oura, may also be mentioned; but the great mineral riches of this kingdom chiefly consist in the auriferous and platiniferous sands, the washing of which,—the only treatment which they have hitherto been able to employ for extracting the gold and platinum,—at present occupies all the attention of government. This washing, although carefully executed, is still imperfect, for a considerable portion of gold is not unfrequently lost in the sands. Nevertheless, the product is very considerable, since, in 1829, it was 6100 kilog., that is about 20,000,000 francs.

(To be continued.)



ACCUMULATED ELECTRICITY.



ACCUMULATED ELECTRICITY.

The year 1746 is one of the greatest epochs in the history of electricity, for it was in this year that Mr. Cuneus, of Leyden, witnessed some of the effects of accumulated electricity, by the accidental discovery of the Leyden phial, or that instrument by means of which the electric fluid may be concentrated, and yet be left free to exert its full effect. Mr. Cuneus, reflecting that the electric fluid could not be accumulated unless the body electrified were insulated, and also, that even then the air around it was constantly drawing off a portion, imagined that a conducting body, if wholly surrounded with glass, instead of being merely supported by it, might be more highly charged, tried the experiment, by inclosing a nail in a wine bottle, and then charging it by contact with a wire proceeding from the prime conductor of the machine. This being done, holding the bottle in one hand and trying to withdraw the nail with the other, he felt a shock, and thus the great discovery was at once completed.

Professor Muschenbroeck next felt the shock; he says, in a letter to Mr. Reaumur, that he felt himself struck in the arms, shoulders, and breast, so that he lost his breath, and was two days before he recovered; he says, he would not take another for the whole kingdom of France. But the dreadful account given by Mr. Winkler is the most curious; he says, he felt great convulsions in his body, that it put his blood into great agitation, so that he was fearful of a fever, to avoid which he was obliged to use refrigerating medicines; he also felt great heaviness in his head as if a stone lay upon it, and twice, he says, it gave him a bleeding at the nose, to which he was not subject. Notwithstanding this astonishing effect, his wife was not satisfied in witnessing its power upon her husband, she wished to see as well as feel it; her fears, if not her prudence, we might have supposed would have restrained her curiosity;—but no, she, it appears, has an uncommon share of this attribute, and, kill or cure, she was determined to have a shock. It is said, that having received it only twice, for she had courage to take a second, she found herself so weak that she could hardly stand.

This panic, however, was far from being general among electricians; and now that we know how trivial must be the shock from so small an apparatus, we cannot help smiling at the fear displayed, nor wondering at the power of imagination, in thus magnifying such a trifle into an instrument of terror.

The Leyden jar is nearly as simple now as it was then; and easy as electrical instruments, in general, are to use and make, this is one of the most so. It consists of a glass phial, or jar, of any size, it is usually made with a large mouth, for the sake of convenience. The lower part is lined with tin-foil, to about two inches from the top; the outside is also covered with tin-foil up to the same line, as is seen in Fig. 1. There is a wire, with a ball at top, connected with the inner coating, and the jar is complete, and being dried and slightly warmed, is fit for use; for the greater convenience of holding the ball and wire tight, the jar is usually made with a wooden lid at top, and a chain reaching from the wire, which is fastened to the lid, down to the bottom of the phial, where it rests upon the inner coating.

Note.—When there is a lid, it should be made of baked wood, and turned with smooth edges; and if the phial have a neck too small to admit the tin-foil conveniently, it may be partly filled with water, or metallic filings. It may be as well also to remark, that tin-foil may be had of the pewterer's, at 3*d.* or 6*d.* per roll, and that nothing is better to stick it on with than common paste.

Electrical Battery.—This, which is represented in Fig. 2, consists of a certain number of Leyden phials, the inner coatings of all which are connected together by wires, and the outer coatings also connected together, the box being lined with tin-foil, a wire passing through the box and furnished with a hook or staple outside, enables the electrician to make his requisite connections with facility.

Ex. 48.—*To Charge and Discharge a Jar.*—Place the brass ball of a coated jar in contact with the prime conductor, while the outside communicates with the table, turn the cylinder, and the bottle will in a little time be charged, or modify the electric fluid in a peculiar manner. To discharge the jar, or restore it to its natural state, bring one end of a conducting substance in contact with the outside coating, and let the other be brought near the knob of the jar which communicates with the inside coating, a strong explosion will take place, the electric light will be visible, and the report very loud.

If a charged jar is coated very high, it will discharge itself before it has received near the charge it would take if the coating was lower. If it is coated very low, this part of the surface may be charged very high, but a considerable part of the glass is not charged at all.

When a jar is charged very high, it will often explode or discharge itself over the glass from one coated surface to the other; or, if the glass is thin, it will make a hole through it, and swell the coating on both sides, the glass in the hole will be pulverized, and very often a variety of fissures will proceed from it in various directions.

A Leyden jar very often recovers its electricity, in a small degree, after a discharge has been made; this second explosion is called the residuum of a charge. The form or size of the glass is no ways material to the receiving of a charge.

Ex. 49.—*Franklin's Explanation.*—The phenomena attending this very extraordinary experiment seemed totally inexplicable, till they were elucidated by the ingenious theory of Dr. Franklin; which, in a plain and clear manner, accounts for most of the difficulties which attend this intricate branch of electricity; and accommodates itself so easily and satisfactorily to a variety of appearances, as to make us almost lose sight of the objections against it.

Glass is supposed to contain at all times, on its two surfaces, a large quantity of the electric fluid; which is so disposed, that if you increase the quantity on one side, the other must throw off an equal proportion; or, when one side is positive, the other must be negative; now, as no more of the electric fluid can be forced on one side than can go off on the other, there is no more in the bottle after it is charged than was there before; the quantity is neither increased or lessened on the whole, though a change may be made in its place and situation; *i. e.* we may throw an additional quantity on one of its sides, if, at the same time, an equal quantity can escape from the other, and not otherwise. That this change is effected by lining parts of its two

surfaces with a non-electric; through the mediation of which, we are enabled to convey the electric fire to every physical point of the surface we propose to charge, where it exerts its activity in repelling the electric particles naturally belonging to the other side; all of which have an opportunity of escaping by the lining in contact with this surface, which, for that purpose, must communicate with the earth; when the whole quantity belonging to this surface has been discharged, in consequence of an equal quantity thrown upon the other surface, the bottle is charged as much as it can possibly be. The two surfaces are at this time in a state of violence; the inner, or positive side, strongly disposed to part with its additional fire, and the outer, or negative side, equally desirous to attract what it has lost, but neither of them capable of having a change in its state effected, without the equal and contemporary participation of the other. That notwithstanding the vicinity of these two surfaces, and the strong disposition of the electric fluid contained in one of them to communicate its super-abundance to the other, and of that to receive it, yet there is an impenetrable barrier between them; for, so impermeable is glass to the electric fluid, (though it permits one side of it to act on the other,) that its two surfaces remain in this state of contrariety till a communication is formed between them, by a proper conductor, when the equilibrium is suddenly and violently restored, and the electric fluid recovers its original state of equality on the two sides of the glass.

Ex. 50.—*To Charge a Sheet of Glass.*—The principle of the Leyden phial is seen very perfectly in a sheet of glass, such as is represented in Fig. 4. Tin-foil is to be pasted on each side, to within an inch or more of the edge; fasten a thread, holding a pith ball, to the tin-foil on each side with a piece of wax; connect one coating with the ground, and touch the prime conductor with the other, the plate of glass will be charged, and the pith balls fly out to some distance; connect the two sides together with a wire, the shock will pass, and the pith balls will become at rest.

Ex. 51.—*To Discharge a Jar gradually with the Finger.*—First, put the jar on an insulating stand, then touch the outer and inner coating alternately with the finger, and a small spark will pass each time, and finally discharge the jar.

Ex 52.—*Electric Pendulum.*—Construct an instrument of wire, with pith balls at the end of it, as represented in Fig. 5. Hang this on the charged plate of glass, when it will vibrate, so that its balls touch each side alternately, and finally discharge the jar.

Ex. 53.—*Magic Picture.*—Procure a frame of dry wood, and furnish it with a glass, as a picture-frame usually is, cover this with tin-foil, as in Ex. 50.; cover the back with a loose piece of dark paper, or a thick dry pasteboard, cutting a small hole in the middle, in order to bring through it a strap of tin-foil, which is pasted upon the coating of the under side of the glass, and reaches to the frame; now cover the tin-foil on the face of the glass with a picture of any kind, and the instrument is complete. To use it, put a piece of money on the picture, and holding it by the frame where the tin-foil is, charge the picture by presenting a ball from the conductor to the money. When charged, take hold of the frame by the other hand, at some other part of the frame, and direct another person to hold that part which you have just quitted with one hand, and to take off the money with the other, his attempt to do so will discharge the sheet of glass, and he receive a shock in the fingers, while he will be quite unable to take off the money. This amusing apparatus is represented in Fig. 7.

Ex. 54.—*To show that an Insulated Jar cannot be Charged.*—Screw a Leyden phial, whose coating is free from points, upon an insulated stand, and place it so that its knob may be in contact with the conductor, (taking care that no conducting substance is near the coating of the jar,) turn the cylinder round a sufficient number of times to charge the phial, then examine it with a discharging rod, and you will find it had received no charge; which shows clearly, that except the electric fluid can escape from one side of the jar, it can receive none on the other.

Ex. 55.—*To Charge a Jar negatively.*—Insulate two Leyden bottles; let their coatings be in contact, and while you charge the inside of one positively, let a person, standing on the floor, touch the top of the other with his finger, and it will be charged negatively.

Ex. 56.—*To Discharge a Jar silently.*—Procure a Leyden jar, which has a hole in the top of the ball, charge it, insulate it, then screw a pointed wire on to the ball. This will soon discharge the jar silently, or the orrery or flyer formerly described may be substituted for it.

Ex. 57.—*Electrical Spider.*—Make an object in the shape of a spider—its body of cork, with eight legs of white thread, about an inch long, and suspend it by a black silk thread. This will play between the knobs of two phials, if one be electrified positively, and the other negatively; or will discharge a phial, if suspended at an equal distance from the knob at the top, and a knobbed wire proceeding from the bottom of it.

Ex. 58.—*Diamond Jar.*—Take a bottle, whose exterior coating is formed of small pieces of tin-foil, placed at a little distance from each other. Charge this bottle in the usual manner, and strong sparks of electricity will pass from one spot of tin-foil to the other, in a variety of directions; the separation of the tin-foil making the passage of the fluid from the outside to the table visible. Discharge this bottle, by bringing a pointed wire gradually near the knob, and the uncoated part of the glass between the spots will be pleasingly illuminated, and the noise will resemble that of small fired crackers. If the jar is discharged suddenly, the whole outside surface appears illuminated. To produce these appearances the glass must be very dry.

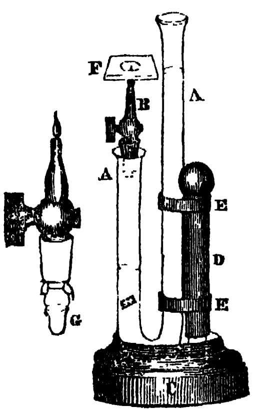
(To be continued.)

MARSH'S APPARATUS FOR DETECTING ARSENIC.

In the early part of 1836, a paper was presented to the Society of Arts, by Mr. James Marsh, of the Royal Arsenal, Woolwich, descriptive of *A Method of separating small Quantities of Arsenic, from Substances with which it may have been mixed.* The merit of this paper was estimated so highly, that the large gold medal of the Society was awarded to the author: and further, so admirable was the simplicity and efficacy of the process, so little the preparation and cost of apparatus necessary to make a most exquisite analysis, and so important to the public interest was the object of the process, that

the Society ordered the instant publication of the paper, instead of imprisoning it in the pigeon-holes of the secretary, until the next succeeding volume could be published. Equally impressed with the importance and excellence of the process of Mr. Marsh, which has been so prominently before the public owing to the late celebrated trial of Madame Laffarge, we are induced to present it to our readers, satisfied that they will be struck with the beauty of this ingenious and practical application of chemical science. Mr. Marsh introduces the subject by stating, that

"The requisite apparatus is as simple as possible; being a glass tube open at both ends, and about three quarters of an inch in its internal diameter. It is bent into the form of a syphon, A A, the shorter leg being about five inches, and the longer about eight inches in length. A stop-cock B, ending in a jet of fine bore, passes tightly through a hole made in the axis of a soft and sound cork, which fits air-tight into the opening of the lower bend of the tube, and may be further secured, if requisite, by a little common turpentine lute. To fix the apparatus when in use, in an upright position, a hole is made in the wooden block C for the reception of the lower part of the pillar D, and a groove is cut in the top of the same block, to receive the bend of the tube A A. Two elastic slips E E, cut from the neck of a common bottle of India rubber, keep the tube firm in its place.



"The matter to be submitted to examination, and supposed to contain arsenic, if not in the fluid state, such as pastry, pudding or bread, &c., must be boiled with two or three fluid ounces of clean water, for a sufficient length of time.

"The mixture so obtained must then be thrown on a filter to separate the more solid parts: thick soup or the contents of the stomach, may be diluted with water and also filtered: but water-gruel, wine, spirits, or any kind of malt liquor and such like, or tea, coffee, cocoa, &c., can be operated on without any previous process.

"When the apparatus is to be used, a bit of glass rod, about an inch long, is to be dropped into the shorter leg, and this is to be followed by a piece of clean sheet zinc, about an inch and a half long and half an inch wide, bent double, so that it will run down the tube till it is stopped by the piece of glass rod first put in. The stop-cock and jet are now to be inserted, and the handle is to be turned so as to leave the cock open. The fluid to be examined, having been previously mixed with from a drachm and a half to three drachms of dilute sulphuric acid (1 acid and 7 water), is to be poured into the long leg, till it stands in the short one about a quarter of an inch below the bottom of the cork. Bubbles of gas will soon be seen to rise from the zinc, which are pure hydrogen if no arsenic be present; but, if the liquor holds arsenic in any form in solution, the gas will be arsenuretted hydrogen. The first portions are to be allowed to escape, in order that they may carry with them the small quantity of common air left in the apparatus; after which the cock is to be closed, and the gas will be found to accumulate in the shorter leg, driving the fluid up the longer one, till the liquor has descended in the short leg below the piece of zinc, when all further production of gas will cease. There is thus obtained a portion of gas subject to the pressure of a column of fluid of from seven to eight inches high: when, therefore, the stop-cock is opened, the gas will be propelled with some force through the jet, and, on igniting it as it issues (which must be done quickly by an assistant), and then holding horizontally a piece of crown or window-glass F, over it, in such a manner as to retard slightly the combustion, the arsenic (if any be present) will be found deposited in the metallic state on the glass; the oxygen of the atmosphere being employed in oxydizing the hydrogen only during the process. If no arsenic be present, then the jet of the flame as it issues has a very different appearance; and, although the glass becomes dulled in the first instance by the deposition of the newly-formed water, yet such is the heat produced, that in a few seconds it becomes perfectly clear, and frequently flies to pieces. [Mr. Herapath advises talc to be used instead of glass.—Ed.]

"If the object be to obtain the arsenic in the form of arsenious acid, or white arsenic, then a glass tube, from a quarter to half an inch in diameter (or according to the size of the jet or flame), and eight or ten inches in length, is to be held vertically over the burning jet of gas, in such a manner that the gas may undergo perfect combustion, and that the arsenic combined with it may become sufficiently oxydized; the tube will thus, with proper care, become lined with arsenious acid in proportion to the quantity originally contained in the mixture.

"When the glass tube is held at an angle of about 45° over the jet of flame, three very good indications of the presence of arsenic may be obtained at one operation; viz., metallic arsenic will be found deposited in the tube at the part nearest where the flame impinges,—white arsenic or arsenious acid at a short distance from it,—and the garlic smell can be readily detected at either end of the tube in which the experiment has been made.

"As the gas produced during the operation is consumed, the acid mixture falls into the short limb of the tube, and is thus again brought into contact with the zinc, in consequence of which a fresh supply is soon obtained. This gas, if submitted to either of the processes before described, will give fresh indication of the presence of the arsenic which the mixture may have originally contained; and it will be easily perceived that the process may be repeated as often as may be required, at the will of the operator, till no further proofs can be obtained.

"When certain mixed or compound liquors are operated on in this apparatus, a great quantity of froth is thrown up into the tube, which may cause a little embarrassment by choking the jet. I have

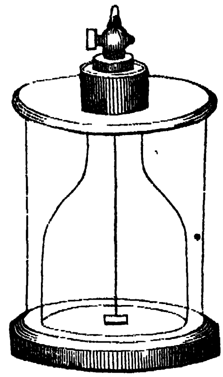
found this effect to take place most with the contents of the stomach, with wine, porter, tea, coffee, or soup, and, indeed, with all mucilaginous and albuminous mixtures. The means I adopt to prevent this effect from taking place, or, at least, for checking it in a great measure, is to grease or oil the interior of the short limb of the apparatus before introducing the subject to be examined, or to put a few drops of alcohol or sweet-oil on its surface previously to introducing the stop-cock and its appendages. I have, however, found, if the tube be ever so full of froth in the first instance, that, in an hour or two, if left to itself, the bubbles burst, and the interior of the tube becomes clear without at all affecting the results.

"In cases where only a small quantity of the matter to be examined can be obtained, I have found a great convenience in using the small glass bucket G. Under such circumstances, the bent glass tube may be filled up to within an inch of the short end with common water, so as to allow room for the glass bucket, which must be attached to the cork, &c. by means of a little platina wire; a bit or two of zinc is to be dropped into the bucket, with a small portion of the matter to be examined, and three or four drops of diluted sulphuric acid (acid 2, water 14); and the whole is then to be introduced into the mouth of the short limb of the tube. The production of gas under this arrangement is much slower, and, of course, requires more time to fill the tube, than in the former case; but the mode of operating is precisely the same. Indeed, it is of great advantage, when the quantity of arsenic present is very minute, not to allow the hydrogen to be evolved too quickly, in order to give it time to take up the arsenic.

"A slender glass funnel will be found of service when as much as a table-spoonful, or even a tea-spoonful, of matter can be obtained for examination. In this case, the tube is to be partly filled with common water, leaving a sufficient space for the substance to be examined; a piece of zinc is to be suspended from the cork by a thread or wire, so as to hang in the axis of the tube; and the fluid to be operated on, having previously been mixed with dilute sulphuric acid, is then to be poured through the funnel carefully, so as to surround the zinc, avoiding, as far as possible, to mix it with the water below, and the stop-cock and its appendages are to be replaced in the mouth of the tube; the production of the gas then goes on as before stated, and the mode of manipulating with it is exactly the same as described in the foregoing part of this paper.

"It will be necessary for me, in this place, to explain the methods I employ after each operation to determine the integrity of the instrument, so as to satisfy myself that no arsenic remains adhering to the inside of the tube, or to the cork and its appendages, before I employ it for another operation.

"After washing the apparatus with clean water, a piece of zinc may be dropped in, and the tube filled to within half an inch of the top of the short limb; two drachms of diluted sulphuric acid are then poured in, and the stop-cock and cork secured in its place; hydrogen gas will in this case, as before, be liberated, and fill the tube. If the gas as it issues from the jet be then inflamed, and a piece of window-glass held over it as before described, and any arsenic remains, it will be rendered evident by being deposited on the glass; if so, this operation must be repeated till the glass remains perfectly clean, after having been exposed to the action of the gas.



"When I have had an opportunity of working with so large a quantity of mixture as from two to four pints (imperial measure), I then have employed the above instrument, which is, indeed, but a slight modification of one of the instantaneous light apparatuses, now so well known and used for obtaining fire by the aid of a stream of hydrogen gas thrown on spongy platinum. It will, therefore, be of importance only for me to describe the alteration which I make when I employ it for the purpose of detecting arsenic. In the first place, I must observe, that the outer vessel, which I use, holds full four pints, and that the jet of the stop-cock is vertical, and its orifice is twice or three times larger than in the instrument as generally made for sale, and also that there is a thread or wire attached to the cork of the stop-cock, for suspending a piece of zinc, within the bell-glass.

"With an instrument of this description I have operated on one grain of arsenic in twenty-eight thousand grains of water (or four imperial pints), and have obtained, therefrom, upwards of one hundred distinct metallic arsenical crusts.

"Similar results have been obtained with perfect success from three pints of very thick soup, the same quantity of port wine, gruel, tea, coffee, &c.

"It must, however, be understood, that the process was allowed to proceed but slowly, and that it required several days before the mixture used ceased to give indication of the presence of arsenic, and also, a much larger portion of zinc and sulphuric acid was employed from time to time, than when working with the small bent tube apparatus, in consequence of the large quantity of matter operated on under this arrangement.

"With the small apparatus, I have obtained distinct metallic crusts, when operating on so small a quantity as one drop of Fowler's solution of arsenic, which only contains 1-120th part of a grain.

"The presence of arsenic in artificial orpiment and realgar, in Scheele's green, and in the sulphuret of antimony, may be readily shown by this process, when not more than half a grain of any of those compounds is employed.

"In conclusion, I beg to remark, that although the instruments I have now finished describing, are the form I prefer to all that I have employed, yet it must be perfectly evident to any one, that many very simple arrangements might be contrived. Indeed, I may say unequivocally, that there is no

town or village in which sulphuric acid and zinc can be obtained, but every house would furnish to the ingenious experimentalist ample means for his purpose; for, a two-ounce phial, with a cork and piece of tobacco-pipe, or a bladder, with the same arrangement fixed to its mouth, might, in cases of extreme necessity, be employed with success, as I have repeatedly done for this purpose.

"The only ambiguity that can possibly arise in the mode of operating above described, arises from the circumstance, that some samples of the zinc of commerce themselves contain arsenic; and such, when acted on by dilute sulphuric acid give out arsenuretted hydrogen. It is, therefore, necessary for the operator to be certain of the purity of the zinc which he employs, and this is easily done by putting a bit of it into the apparatus, with only some dilute sulphuric acid; the gas thus obtained is to be set fire to as it issues from the jet; and if no metallic film is deposited on the bit of flat glass, and no white sublimate within the open tube, the zinc may be regarded as in a fit state for use."

NEW SUN DIAL.

At a recent sitting of the French Academy of Sciences, a report was read of the committee appointed to examine the merits of a sun dial invented by M. de Saulcy for ascertaining the mean time in any latitude.

A sun dial properly set marks the real time at any part of the day; and the mean time is obtained by making allowances for the difference between the real time and the mean time; but in this operation it is necessary to take the equation of time from an astronomical ephemeris, which difference is to be added to or deducted from the real time. It is to save this calculation that M. de Saulcy has invented an apparatus, by means of which the dial can be placed every day in such a position as to mark the mean time of any hour, without the aid of the ephemeris, and by merely knowing the day of the year.

If a sun dial be made to turn round its index, the shadow of the sun will indicate the hour sooner or later, according to the motion having taken place eastward or westward. Thus by giving the dial a proper position, the solar shadows will mark the mean time instead of the real time. The meridian of the dial must be inclined every day according to the meridian of the place, either to the right or left, at an angle equal to the equation of time expressed by degrees. On the day when the equation is null, the dial will mark both the real and the mean time, which will take place four times a year.

When the dial is inclined towards the east, for example, it marks the real time at the part situated in the same latitude, under a distant meridian, at an angle equal to the equation of time. The sun after reaching the meridian of the dial, has still to move for a space equal to the equation of the time, to reach the meridian of the place. It marks thus the real noon of that point, and the mean noon of the place where the dial is placed.

The properties of a dial moving round its index, will be the same when made to turn in the same degree round a line parallel to the index or to the axis of the earth.

The following is a description of M. de Saulcy's sun dial, and of the mode of moving it. He has drawn on a plate of porcelain, about 8 or 9 inches square, a horizontal sun dial, for the latitude of 45°. This dial is attached to an iron rectangular triangle, called *Sellette*, the three sides of which are equal. By this arrangement the hypothenusal line is parallel with the index or gnomon; it is equally parallel with the axis of the earth when the dial is horizontal and properly set. It is round this hypothenuse that the dial is to move, by means of two little pivots fixed to a frame. This frame is like a double desk, being a kind of triangular prism. The large face rests on a horizontal plane, the two others, being equal and opposite to each other, are both inclined 45° to the horizon. It is to the face parallel with the axis of the earth that the two pivots, on which the rectangular triangle turns, are fixed. On the face of the frame parallel to the equator is a toothed wheel, divided into 365 equal parts, for each day of the year. In the centre of this wheel is a circular brass plate, the rays of which vary according to the equation of time. A rod, called *gouvernail*, furnished with a spring which presses against a repeller, the edge of the brass plate, inclines towards the plane of the equator, and gives the angular motion to the triangle which supports the dial, when the toothed wheel is turned by means of a pinion, in order to bring the day of the year under an index properly placed.

The sun dial may be placed on the vertical side of the moveable triangle, and in that case it becomes a vertical sun dial.

When the latitude of the place is more or less than 45°, instead of placing the frame on a horizontal plane, it is to be placed on an inclined plane, equal to the difference between 45° and the latitude of the place, so as to have the gnomon always parallel with the axis of the earth. The plane of the dial, which is neither horizontal nor vertical, will mark the mean time, as if it was placed in 45° of latitude.

This apparatus, made for the northern hemisphere, can be used also in the southern parts of the globe, by placing it in an opposite direction; the morning then becomes evening, and the eccentric curve is to be drawn in the opposite way.

APPLICATION OF THE PHYSICO-CHEMICAL SCIENCES TO ARTS AND MANUFACTURES.

BY M. BECQUEREL.

(Resumed from page 272, and concluded.)

The auriferous and argentiferous galenas, which have been treated for silver and lead by the electro-chemical process, are perfectly disposed for the extraction of the gold by washing. Indeed this treatment requires a pulverisation, and a roasting which disengage the gold from the pyrites and other compounds which retain it; the silver and lead being removed, the ore is found reduced to nearly half its weight, and the washing may then be effected with great facility: the quartz and other light matters are in such a state of division, that a man who is well used to it may wash several hundred kilogrammes a-day. Its application has quite recently been made to the argentiferous galena, a few years ago discovered at Saint-Saintin-Cantalés, department of Cantal, and the quantity of whose gold did not amount to more than a decigramme and a half in 100 kilogrammes of ore, containing 30 per cent of lead. After the electro-chemical treatment and washing, we soon obtain residues which contain 8

grammes of gold, and even more which may advantageously be treated, whether by smelting or by carrying the washing farther. From this we are led to believe that the rocks of this country are auriferous, as also the etymology of Aurillac (*aurilicus*) would tend to prove.

These results confirm the advantages obtained by one of our brethren, in roasting auriferous pyrites, before washing them to extract the gold,—advantages which have been disputed in some countries, especially in Russia. It appears that the scarcity of fuel is the only obstacle to its application on the large scale in America.

Gold is generally found in Columbia, and in the United States, in the rocks known to geologists by the names of syenite, porphyric syenite, mica schist, and gneiss, and the quantity is so much the more considerable as the rocks are in a greater state of decomposition; it is the same in Russia where the auriferous rock is diorite; this general fact, which the principles of electro-chemistry turn to good account, has suggested a very simple mechanical process, which allows of the parts containing gold being immediately separated from those which are deprived of it, so that only a certain portion of the auriferous sands have to be submitted to washing.

If we afterwards seek to determine what advantages may result from metallurgical works, we shall see that they necessarily bring to a desert country the benefits of civilisation, and, where formerly nothing but unoccupied land was found, villages are built without delay; but if, by a wise foresight, power does not make its happy intervention felt, by encouraging agriculture, these localities, which are crowded by a rich population, may soon become nearly deserts,—of which Villa Rica, in Brazil, is an example.

In the time of its greatest prosperity, when the annual produce of the auriferous sands amounted to nearly 120,000,000 francs, its population amounted to 20,000 souls. For a century this vast product has gradually diminished; the inhabitants, wholly occupied in the washing, neglected the benefits which agriculture would have procured them in that beautiful and fertile country.

The distance from the metropolis, domestic troubles, carelessness of administration, and the exactions of power, caused many to emigrate. Scarcely does this town now present to the traveller, the shadow of its former splendor!

It is very different in the districts of the mines of Altaïa, where there is a working population of 25,000, and 120,000 agriculturists. The encouragements granted to the latter are such, that the best cultivated lands are those in the vicinity of the mines. Hence, necessarily results an increase of population which will allow of greater scope being given to the metallurgical operations, as soon as all the hands are not occupied in the clearing and culture of the lands—the only means of peopling these vast countries.

If we now look at the other applications of electricity, we perceive that the same processes which serve for the treatment of metals—with some modifications however—are successfully employed for gilding silver and copper objects, to a degree of perfection which leave nothing to be desired, and likewise for taking impressions in copper, of medals, bas relief and plates engraved with a graver, which have all the beauty and polish of medals. The galvanic moulds copy in relief all the prominent parts of these plates, and the cast copy gives impressions on paper. The number of good impressions which such a plate can furnish is very limited; but there is the advantage of being able to replace it by another, when it begins to wear out.

This power, which by turns becomes, heat, light, and chemical power, is also capable of producing the effects of steam, so far as we can judge from experiments first made in the United States, and more recently in Russia; in the former, it has been applied to the use of a printing press; in the latter, to the navigation of the Neva.

A six-oared sloop, fitted with paddle wheels put in motion by an electric-magnetic machine, acting by means of a small voltaic apparatus sailed up that river, against a very light contrary wind. Certainly if the expense necessary for setting in action an electro-magnetic machine capable of moving a man-of-war were calculated, it is probable that it would be of a nature to cause this new application to be at present abandoned; but when we reflect that bodies contain between their particles an enormous quantity of electricity, and that every day we are able to obtain a greater quantity of this power, at less expense, we are led to hope that we shall one day see it liberated in sufficient quantity to be applied to the purposes of navigation. Thus, far from rejecting the first attempts made in the north for substituting the employment of electric currents for that of steam, we should, on the contrary, encourage investigations, which, perhaps, will lead to the solution of one of the greatest manufacturing questions which could be proposed.

The powers by aid of which the metals are extracted from their ores have such energy, that they may one day be used for setting in motion apparatus for grinding, and making ore undergo the various mechanical preparations without which the treatment could not be carried on.

In the face of so many facts, whose importance is every day better appreciated, it is easy to perceive that the future may derive from the employment of a force whose power may be called infinite, which exists fettered and neutral wherever there is matter, and of which man will perhaps one day be able to make himself master.

In examining the present in order to prejudge the future we shall see that the imperative wants caused by the increase of population, resulting from the progress of civilisation, will require the forests to be cleared; that coal pits are not inexhaustible, and that a time must come when the scarcity of fuel will be a serious obstacle to metallurgical operations. This time is, it is true, yet very far distant, but let us now prepare, for the benefit of posterity, the means of extracting metals from their ores, and of carrying on various manufactures, without the intervention of fires.

PREPARATION OF PIGMENTS.

(*Resumed from page* 256.)

BROWNS.

ASPHALTUM, or bitumen, is a species of pitch, or mineral oil become solid. Bitumen is collected on the surface of the lake Asphaltites, (the Dead Sea,) and is called "Jew's pitch;" but the greater part of the asphaltum of commerce is derived from liquid asphaltum, which is evaporated to dryness. The bitumen is of a fine black tint in its fracture, is easily pulverized, and its powder is brown. It is not ground—it is only melted, and a fine brown color is thus obtained, of the greatest transparency,

but it retards the drying of oils, and the drying quality must be increased as much as possible. There are two modes of preparing bitumen: a thick varnish is first made by dissolving it in oil of turpentine; this does not require much heat, and even, in time, will dissolve when cold. This varnish is so thick that it cannot be used without mixing it with the emplastic oil of Italy, or mastic varnish; this prevents its flowing off the palette. This is the manner in which the English and the Italians prepare bitumen.

The French prepare it in the following manner:

Venice turpentine	15	grains.
Gum lac	60	,,
Asphaltum	90	,,
Drying oil	240	,,
White wax	30	,,

The gum lac is first dissolved in the turpentine by adding fifteen grains at a time, and allowing it to melt before the other portion is added; the asphaltum is then to be mixed in like manner, by degrees; the linseed oil, having been heated near to the boiling point, is also by degrees mingled with the rest: the wax is then added. Before the mixture cools, it should be thrown upon the stone, and well worked with the muller and knife. Thus prepared, the bitumen will dry in one day equal to flake white; but as a skin will form on the surface of the mass, this must be prevented by putting it into a tin cylindrical vessel, covered with a disc of the exact diameter of the interior. By pressing this disc, in which is a small hole, the bitumen oozes out, and then the hole is closed with a wooden peg, so as to prevent the air coming in contact with the surface of the liquid. In this way it may be preserved soft for a long time.

A greater degree of solidity would be given to the bitumen if it were dissolved in amber varnish; sixty grains of this varnish should be substituted for turpentine. The gum lac will dissolve readily in the varnish.

Brown of Prussian Blue.—M. Bouvier has published a process, by means of which Prussian blue may be converted into brown, or black, by intense heat. This brown has all the transparency of asphaltum, with this advantage, that it dries quickly, and is permanent.

Mr. Bouvier's process is, to place upon a clear fire a large iron spoon; when it is red hot, put into it some pieces of Prussian blue about the size of a small nut; these soon begin to crackle, and throw off scales in proportion as it grows hot; remove the spoon, and let it be cool: if allowed to remain too long on the fire, the right color is crushed small, some of it will be found blackish, and the rest of a yellowish brown: this is quite as it should be.

M. Bouvier states that this pigment can only be obtained from the genuine Prussian blue in common use. He states, that he "never succeeded in making it with that sort which is manufactured in England." Thus it would appear, that to make the operation certainly succeed, blue must be employed in which there is much alumine. That of English manufacture, which is darker than the French, contains but little of this substance: when completely calcined, the English blue only produces a sort of orange color, which is, in fact, very transparent and intense. Another condition requisite to the success of the operation is, that the heat ought to be at once carried to the exact point required. This is easily done by using proper caution. Instead of commencing the process by heating an iron spoon, the bits of color may be placed on a plate of iron, and the plate laid upon a quick fire; they sometimes give out flame, and always grow red along with the plate; when taken off the fire, they are left until they cease to emit smoke, and the blue color has disappeared.

If the blue is calcined in a close crucible, a black is formed, which will be found very useful, as it dries well.

Brown Pink.—This color is made by precipitating, with alum, a decoction of French berries (*rhamnus infusorius*) in such a way as that the alkali shall not be saturated. This color would be more lasting if, instead of the berries, yellow wood, quercitron, and holly bark, for instance, were used; and still better would be the husks of nuts, which produce a very lasting brown color. The husks of nuts contain some portion of starch: for this reason it would not be proper to employ boiling water for the purpose of extracting the color.

Mixture may also be made, in whatever proportions are most agreeable, of wood, madder, and husks of nuts; and instead of using alum to precipitate the decoction, the acetate or sulphate of copper should be used, which, as we have already observed, is the best mordant for giving stability to the colors. Bones, or ivory half calcined, produce very transparent browns, and are lasting, but are the worst driers possible.

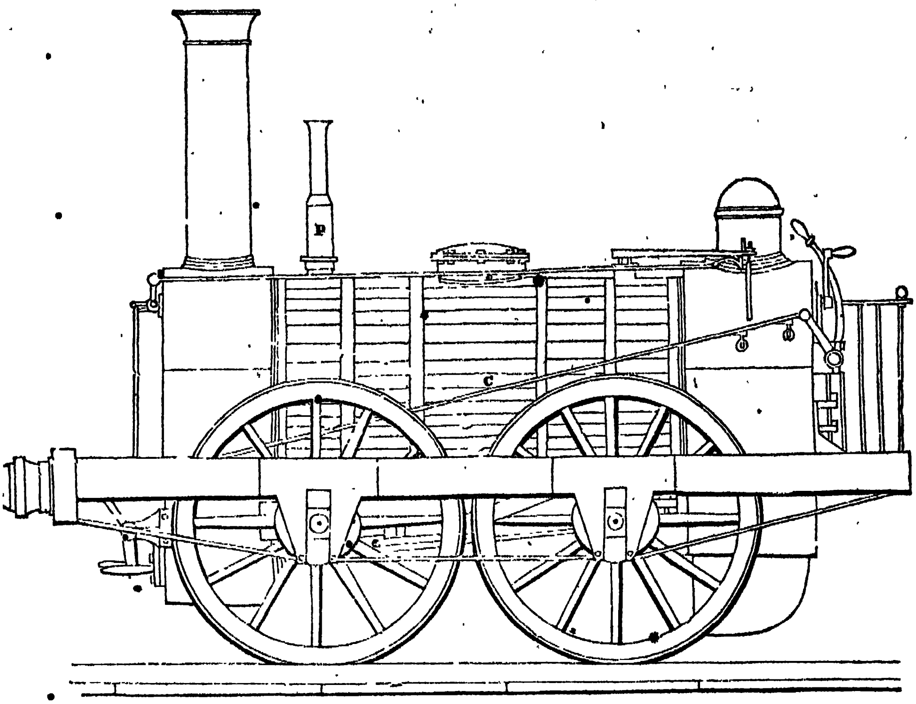
Umber.—Some mineralogists have confounded this earth with that of *nocera in umbria*, which is bituminous and inflammable, like those of Cassel and Cologne. It resists the action of fire like the ochres. It is brought from the Isle of Cyprus, and is known in commerce as Turkish or Levant umber. Its color is an olive brown, which becomes much darker, and of a warmer tone, when it is calcined. It is principally composed of the oxide of manganese, oxide of iron, silex, and alumine. This color has much body, and dries rapidly, especially after it has been calcined. It grows darker by time; but this is not a reason for setting it aside: this disadvantage may be obviated by mixing it with colors which grow paler by the action of light, such as the brown pinks, &c.

Some painters have painted on grounds primed with umber, but it has penetrated through the lighter parts of the work. There are several of Poussin's pictures painted on umber grounds. That fine series, "The Seven Sacraments," is clearly amongst them.

Cassel and Cologne Earths.—These are bituminous earths, originating as it is supposed from the decomposition of wood; the mineralogists have also given them the name of lignites. The Cassel earth has the greater quantity of bitumen, and has a rich tone of color, but it loses this in some measure by exposure to the light. Another serious inconvenience in the bituminous earths, is their retarding the drying of the oils; therefore when employed, they must be ground with the strongest drying oils; and to compensate for their growing lighter by the action of the air, they should be mixed with colors that are permanent, such as umber, charcoal-black, and oxide of iron.

(To be continued.)

Fig. 1.



LOCOMOTIVE ENGINES.

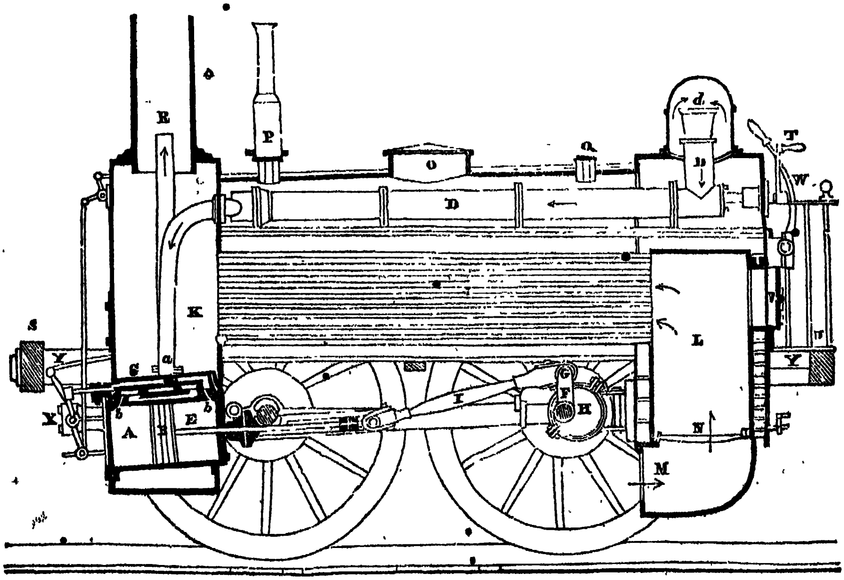


Fig. 2.

LOCOMOTIVE ENGINES.

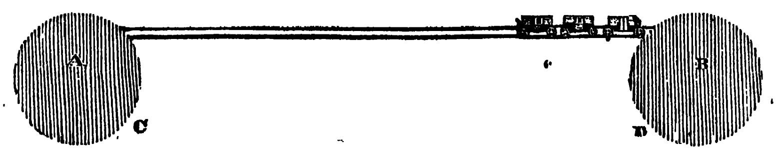
To the Editor.

SIR.—Having on several occasions been much pleased in perusing your little work, and wishing to promote its circulation, I have sent you a drawing and description of a locomotive engine, which I hope will be sufficiently lucid for the generality of your subscribers.

As railways occupy a large share of public interest at the present time, it is important that some insight should be had into the manner of working them, and the construction of the various machines which are used for the transportation of passengers and merchandise over the greater part of this country.

Various means are resorted to, and power of different descriptions made use of for this purpose, viz., steam engines, locomotive and stationary, the pressure of the atmosphere, as in the atmospheric railway, and the gravity of the carriages themselves, which is made use of in some of the railways in the north, connected with the collieries, where an endless rope passes round drums at each end of the line, which is an inclined plane, the train of laden carriages running down which, on one line of rails, draws up the empty train on the other line

Of steam engines, where stationary power is employed for the purposes of locomotion, and endless rope is employed, as in the London and Birmingham railway, worked by an engine at one end of the line only; or a tail rope is used, as in the London and Blackwall railway. In this case, an engine is placed at each end of the line, which will be better understood by the following sketch:



Supposing the train to be starting from the terminus D, there will be as much rope wound on the drum B, as is stretched between the two drums B and A: the drum A being then made to revolve, unwinds the rope from B, drawing the train with it, and by the time the train has reached the terminus C the drum A will be full of rope and B empty.

But of all these contrivances the locomotive engine is the most in use, and which I shall proceed to describe.

The arrangement of the various parts of this machine is admirably adapted to the objects in view, viz., compactness, great surface of heat, an object attained by causing the smoke and heat to pass through the copper tubes J, which were added by Mr. Stephenson, and are a very great assistance; small surface for condensation, the cylinders being placed in the smoke box exposed to a great heat, and the boiler being covered with wood; and a good draught, caused by making the steam, after having performed its duty in the cylinders, pass up the chimney through the waste steam pipe R, causing a vacuum, the air to supply which must enter through the opening M, up through the fire. These engines are generally about 20-horse power, weighing about 16 tons. They cost from 12 to £1500, and when well made and in good condition attain a speed of 68 miles per hour, in which time they evaporate 100 cube feet of water, and consume 900 or 1000lb. of coke. They are provided with a tender or open carriage, for carrying water and fuel, and a steam whistle to warn persons on the railway of their approach.

A the cylinder, of which there are a pair. B the piston. C the D valve. D the steam-pipe. E the piston rod. F the axle of the driving wheels. G the crank. H the eccentric working the D valve. I the rod connecting the piston rod with the crank. J copper tubes to convey the smoke from L the fire-box to K the smoke-box. M an opening to cause draught. N the fire bars. O the man-hole. P a safety-valve not under the control of the engine-driver, loaded with a pressure of 50lbs. per square inch. Q a safety-valve regulated by the engine-driver. R the waste steam-pipe. S buffers to lessen the shock of a collision. T the handle of the cock for regulating or shutting off the steam pipe D. U the platform for the engine-driver. V the door to the fire-box. W the handle to the reversing motion connected with it by the rod C C. Y the frame to the engine. A. F.

MAKING OF GLASS BEADS.

A VERY considerable manufacture of glass for the formation of beads is carried on at a place called Murano, situated near the city of Venice. There is nothing peculiar in the composition of the glass made use of for this purpose, nor in the methods employed for its preparation; and although the manufacturers affect great secrecy as to the coloring substances which they mix with this glass, it is not likely that they possess any real advantage over others in this respect, or that they have made any useful discovery of materials different from those commonly employed in coloring glass.

When upon inspection the colored glass is found to be in a fit state for working, the necessary quantity is gathered in the usual manner upon the rod, and is blown into a hollow form. A second workman then provides himself with an appropriate instrument, with which he takes hold of the glass at the end which is farthest from the extremity of the rod, and the two men running thereupon expeditiously in exactly opposite directions, the glass is drawn out into a pipe or tube, in the manner of those used for constructing thermometers, the thickness of which depends upon the distance by which the men separate themselves. Whatever this thickness may be, the perforation of the tube is preserved, and bears the same proportion relatively to the substance of the glass as was originally given to it by the blower. In these particulars the workmen of course govern themselves according to the size and description of the beads which are to be made. The glass-house at Murano is provided with a kind of gallery 150 feet in length, and which much resembles a rope-walk,

wherein the tubes are drawn out in the manner described.

Tubes striped with different colors are made by gathering from two or more pots lumps of different colored glass, which are united by twisting them together before they are drawn out to the requisite length.

As soon as they are sufficiently cool for the purpose, the tubes are divided into equal lengths, sorted according to their colors and sizes, packed in chests, and then despatched to the city of Venice, within which the actual manufacture of the beads is conducted.

When they arrive at the bead manufactory, the tubes are again very carefully inspected, and sorted according to their different diameters, preparatory to their being cut into pieces sufficiently small for making beads.

For performing this latter operation, a sharp iron instrument is provided, shaped like a chisel, and securely fixed in a block of wood. Placing the glass tube upon the edge of this tool at the part to be separated, the workman then, with another sharp instrument in his hand, cuts, or rather chips, the pipe into pieces of the requisite size; the skill of the man being shown by the uniformity of size preserved between the different fragments.

The minute pieces thus obtained are in the next process thrown into a bowl containing a mixture of sand and wood ashes, in which they are continually stirred about until the perforations in the pieces are all filled by the sand and ashes. This provision is indispensable, in order to prevent the sides from falling together when softened by heat in the next operation.

A metallic vessel with a long handle is then provided, wherein the pieces of glass are placed, together with a further quantity of wood-ashes and sand; and the whole being subjected to heat over a charcoal fire, are continually stirred with a hatchet-shaped spatula. By this simple means the beads acquire their globular form.

When this has been imparted, and the beads are again cool, they are agitated in sieves, in order to separate the sand and ashes; this done they are transferred to other sieves of different degrees of fineness, in order to divide the beads according to their various sizes. Those of each size are then, after being strung by children upon separate threads, made up into bundles, and packed in casks for exportation.

In this manner, not fewer than sixty different kinds of glass beads are prepared in vast quantities. The principal trade in these is carried on with Spain and the coast of Africa; but some portions find their way to nearly all parts of the world.

FIREWORKS.

(Resumed from page 245.)

Crackers.—Cut some cartridge paper into pieces 3½ inches broad, and 1 foot long; 1 edge of each fold down lengthwise about ¾ of an inch broad; then fold the double edge down ¼ of an inch, and turn the single edge back half over the double fold; then open it, and lay all along the channel which is formed by the folding of the paper, some meal powder; then fold it over and over, till all the paper is doubled up, rubbing it down every turn; this done, bend it backwards and forwards, 2½ inches, or thereabouts at a time, as oft as the paper will allow; then hold all these folds flat and close, and with a small pinching cord give one turn round the middle of the cracker, and pinch it close; then bind it with pack-thread, as tight as you can; then in the place where it was pinched, prime one end of it, and cap it with touch-paper. When these crackers are fired, they will give a report at every turn of the paper: if you would have a great number of bounces, you must cut the paper longer, or join them after they are made; but if they are made very long before they are pinched, you must have a piece of wood with a groove in it, deep enough to let in half the cracker: this will hold it straight, while it is pinching.

Marroons.—Formers for marroons are from ¾ of an inch to 1½ diameter. Cut the paper for the cases twice the diameter of the former broad, and long enough to go three times round; when you have rolled a case, paste down the edge, and tie one end close; then with the former drive it down to take away the wrinkles, and make it flat at bottom; then fill the case with corn powder 1 diameter and ½ high, and fold down the rest of the case tight on the powder. The marroon being thus made, wind pack-thread up in a ball, then unwind 2 or 3 yards of it, and that part which is near the ball, make fast to a hook; then take a marroon, and stand as far from the hook as the pack-thread will reach, take some rope yarn and wind it lengthwise round the marroon as tight as you can, till it will hold no more that way; then turn it and wind the pack-thread on the short way, then lengthwise again, and so on till the paper is all covered; then make fast the end of the yarn, and beat down both ends of the marroon, to bring it in shape. To consolidate the whole dip it in hot glue in which red lead has been mixed. The method of firing marroons, is by making a hole at one end with an awl, and putting in a piece of quick-match; then take a piece of strong paper, in which wrap up the marroon, with 2 leaders, which must be put down to the vent, and the paper tied tight round them with small twine; these leaders are bent on each side, and their loose ends tied to other marroons; that is, whenever numbers are to be fired at once, otherwise, a single leader is sufficient.

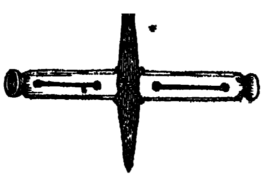
Pin-wheels.—First roll some paper pipes, about 14 inches long each: these pipes must not be made thick of paper, 2 or 3 rounds of elephant paper being sufficient. When your pipes are thoroughly dried, you must have made a tin tube, 12 inches long to fit easy into the pipes; at one end of this tube fix a small conical cup, which done is called a funnel: then bend one end of one of the pipes, and put the funnel in at the other, as far as it will reach, and fill the cup with composition: then draw out the funnel by a little at a time, shaking it up and down; and it will fill the pipe as it comes out. Having filled some pipes, have made some small blocks, about 1 inch diameter, and ½ inch thick; round one of these blocks wind and paste a pipe, and to the end of this pipe join another; which must be done by twisting the end of one pipe to a point, and putting it into the end of the other, with a little paste: in this manner join four or five pipes, winding them one upon the other, so as to form a spiral line. Having wound on your pipes, paste two slips of paper across them, to hold them together: besides these slips of paper the pipes must be pasted together.

There is another method of making these wheels, called the French; which is, by winding on the pipes without paste, and sticking them together with sealing-wax, at every half-turn; so that, when they are fired, the end will fall loose every time the fire passes the wax; by which means the circle of fire will be considerably increased. The formers for these pipes are made from 1½ to 4 16ths of an inch diameter, and the composition for them is as follows; meal powder 8 oz., saltpetre 2 oz., and sulphur 1 oz.: among these ingredients may be mixed a little steel-filings, or the dust of cast iron: this composition should be very dry, and not made too fine, or it will stick in the funnel. These wheels may be fired on a large pin, and held in the hand with safety.

Serpents.—Serpents are generally made about 5 or 6 inches long, and about half an inch in diameter, they are sometimes made straight, and sometimes with a choak in the middle of them: the name which they bear, probably rose from the hissing noise which they make when fired, or from the zigzag or vibrating directions in which they move when properly constructed. The cases must be made of some strong paper, and rolled in a former about one-fourth of an inch diameter, or somewhat more, and having choaked or tied one end up close, with strong twine, fill the case about two-thirds of the way with the following composition: mealed-powder 1 pound, saltpetre 1 oz. and ¾, charcoal 1 oz.

To make Tourbillon Cases.—Those sort of cases are generally made about 8 diameters long, but if very large, 7 will be sufficient: tourbillons will answer very well from 4 oz. to 2lb., but when larger there is no certainty. The cases are best rolled wet with paste, and the last sheet must have a straight edge, so that the case may be all of a thickness: when you have rolled your cases, after the manner of wheel cases, pinch them at one end quite close; then, with the rammer, drive the ends down flat, and afterwards ram in about 1-3rd of a diameter of dried clay. The diameter of the former for these cases must be the same as for sky-rockets.

Tourbillon.—Having filled some cases within about 1½ diameter, drive in a ladle-full of clay, then pinch their ends close, and drive them down with a mallet; when done, find the centre of gravity of each case, where you nail and tie a stick, which should be ½ an inch broad at the middle, and run a little narrower to the ends: these sticks must have their ends turned upwards, so that the cases may turn horizontally on their centres: at the opposite sides of the cases, at each end, bore a hole close to the clay with a gimblet, the size of the neck of a common case of the same nature; from these holes draw a line round the case, and at the under part of the case bore a hole, with the same gimblet, within ½ a diameter of each line towards the centre, then from one hole to the other draw a right line. This line divide into three equal parts, as in the Figure,



bore two holes, then from these holes to the other two, lead a quick-match, over which paste a thin paper. When you fire tourbillons, lay them on a smooth table, with their sticks downwards, and burn the leader through the middle with a port fire. They should spin three or four seconds on the table before they rise, which is about the time the composition will be burning, from the side holes to those at bottom.

To tourbillons may be fixed reports, in this manner: in the centre of the case at top, make a small hole, and in the middle of the report make another; then place them together, and tie on the report, and with a single paper secure it from fire: this done, your tourbillon is completed. By this method you may fix on tourbillons, small cones of stars, rains, &c. but be careful not to load them too much 18th of an inch will be enough for the thickness of the sticks, and their length equal to that of the cases.

Composition of Tourbillons.—Fill with rocket composition of a strength proportionate to the size of the case.

(To be continued.)

PARALLAX.

The parallax of a celestial body is the angle under which the radius of the earth would be seen, if viewed from the centre of that body; it affords the means of ascertaining the distances of the sun, moon, and planets. When the moon is in the horizon at the instant of rising or setting, suppose lines to be drawn from her centre to the spectator and to the centre of the earth: these would form a right-angled triangle with the terrestrial radius, which is of a known length; and as the parallax or angle at the moon can be measured, all the angles and one side are given; whence the distance of the moon from the centre of the earth may be computed. The parallax of an object may be found, if two observers under the same meridian, but at a very great distance from one another, observe its zenith distances on the same day at the time of its passage over the meridian. By such contemporaneous observations at the Cape of Good Hope and at Berlin, the mean horizontal parallax of the moon was found to be 3459″, whence the mean distance of the moon is about sixty times the mean terrestrial radius, or 237,360 miles nearly. Since the parallax is equal to the radius of the earth divided by the distance of the moon, it varies from the distance of the moon from the earth under the same parallel of latitude, and proves the ellipticity of the lunar orbit. When the moon is at her mean distance, it varies with the terrestrial radii, thus showing that the earth is not a sphere.

Although the method described is sufficiently accurate for finding the parallax of an object so near as the moon, it will not answer for the sun, which is so remote that the smallest error in observation would lead to a false result. But that difficulty is obviated by the transits of Venus. When that planet is in her nodes, or within 1¼° of them, that is, in, or nearly in the plane of the ecliptic, she is occasionally seen to pass over the sun like a black spot. If we could imagine that the sun and Venus had no parallax, the line described by the planet on his disc, and the duration of the transit would be the same to all the inhabitants of the earth. But as the semi-diameter of the earth has a sensible magnitude when viewed from the centre of the sun, the line described by the planet in its passage over

his disc appears to be nearer to his centre, or farther from it, according to the position of the observer; so that the duration of the transit varies with the different points of the earth's surface at which it is observed. This difference of time, being entirely the effect of parallax, furnishes the means of computing it from the known motions of the earth and Venus, by the same method as for the eclipses of the sun. In fact, the ratio of the distances of Venus and the sun from the earth at the time of the transit are known from the theory of their elliptical motion. Consequently the ratio of the parallaxes of these two bodies being inversely as their distances, is given; and as the transit gives the difference of the parallaxes, that of the sun is obtained. In 1769, the parallax of the sun was determined by observations of a transit of Venus made at Wardhus in Lapland, and at Otaheite in the South Sea. The latter observation was the object of Cook's first voyage. The transit lasted about six hours at Otaheite, and the difference in duration at these two stations was eight minutes; whence the sun's horizontal parallax was found to be 8''·72. But by other considerations it has been reduced to 8''5776; from which the mean distance of the sun appears to be about ninety-five millions of miles. This is confirmed by an inequality in the motion of the moon, which depends upon the parallax of the sun, and which, when compared with observation, gives 8''·6 for the sun's parallax.

The parallax of Venus is determined by her transits, that of Mars by direct observation, and it is found to be nearly double that of the sun, when the planet is in opposition. The distance of these two planets from the earth is therefore known in terrestrial radii, consequently their mean distances from the sun may be computed; and as the ratios of the distances of the planets from the sun, are known by Kepler's law of the squares of the periodic times of any two planets being as the cubes of their mean distances from the sun, their absolute distances in miles are easily found. This law is very remarkable, in thus uniting all the bodies of the system, and extending to the satellites as well as the planets.

Far as the earth seems to be from the sun, Uranus is no less than nineteen times farther. Situate on the verge of the system, the sun must appear to it not much larger than Venus does to us. The earth cannot even be visible as a telescopic object to a body so remote. Yet man, the inhabitant of the earth, soars beyond the vast dimensions of the system to which his planet belongs, and assumes the diameter of its orbit as the base of a triangle, whose apex extends to the stars.

Sublime as the idea is, this assumption proves ineffectual, for the apparent places of the fixed stars are not sensibly changed by the earth's annual revolution. With the aid derived from the refinements of modern astronomy, and of the most perfect instruments, it is still a matter of doubt, whether a sensible parallax has been detected even in the nearest of these remote suns. If a fixed star had the parallax of one second, it would be 215,789 times farther from the sun than the earth is. At such a distance not only the terrestrial orbit shrinks to a point, but the whole solar system seen in the focus of the most powerful telescope, might be eclipsed by the thickness of a spider's thread. Light flying at the rate of 200,000 miles in a second, would take three years and seven days to travel over that space. One of the nearest stars may therefore have been kindled or extinguished more than three years, before we could have been aware of so mighty an event. But this distance must be small, when compared with that of the most remote of the bodies which are visible in the heavens. The fixed stars are undoubtedly luminous like the sun; it is therefore probable that they are not nearer to one another than the sun is to the nearest of them. In the milky way and the other starry nebulæ, some of the stars that seem to us to be close to others, may be far behind them in the boundless depth of space; nay, may be rationally supposed to be situate many thousand times farther off. Light would therefore require thousands of years to come to the earth from those myriads of suns, of which our own is but "the dim and remote companion."

SHAPE AND HEAT OF THE EARTH.

It has long been a favorite conjecture, that the whole of our planet was originally in a state of igneous fusion, and the central parts still retain a great portion of their primitive heat. Some have imagined with the late Sir W. Herschel, that the elementary matter of the earth may have been first in a gaseous state, resembling those nebulæ which we behold in the heavens, and which are of dimensions so vast, that some of them would fill the orbits of the remotest planets of our system. It is conjectured that such aëriform matter (for in many cases the nebulous appearance cannot be referred to clusters of very distant stars), if concentrated, might form solid spheres; and others have imagined that the evolution of heat, attendant on condensation, might retain the materials of the new globes in a state of igneous fusion.

Without dwelling on such speculations, we may consider how far the spheroidal form of the earth affords sufficient ground for presuming that its primitive condition was one of universal fluidity. The discussion of this question would be superfluous, were the doctrine of original fluidity less popular; for it may well be asked, why the globe should be supposed to have had a pristine shape different from the present one?—why the terrestrials, when first called into existence, or assembled together in one place, should not have been subject to rotation, so as to assume at once that form which alone could retain their several parts in a state of equilibrium?

Let us, however, concede that the statical figure may be a modification of some other pre-existing form, and suppose the globe to have been at first a perfect and quiescent sphere, covered with a uniform ocean—what would happen when it was made to turn round on its axis with its present velocity? "A centrifugal force," says Sir J. Herschel, "would in that case be generated, whose general tendency would be to urge the water at every point of the surface to *recede* from the *axis*. A rotation might indeed be conceived so swift as to flirt the whole ocean from the surface, like water from a mop. But this would require a far greater velocity than what we now speak of. In the case supposed, the *weight* of the water would still keep it *on* the earth; and the tendency to recede from the axis *could* only be satisfied, therefore, by the water leaving the poles, and flowing towards the equator; there heaping itself up in a ridge, and being retained in opposition to its weight or natural tendency towards the centre by the pressure thus caused. This, however, could not take place without laving dry the polar regions,

so that protuberant land would appear at the poles, and a zone of ocean be disposed around the equator. This would be the first or immediate effect. Let us now see what would afterwards happen if things were allowed to take their natural course.

"The sea is constantly beating on the land, grinding it down, and scattering its worn-off particles and fragments, in the state of sand and pebbles, over its bed. Geological facts afford abundant proof that the existing continents have all of them undergone this process, even more than once, and been entirely torn in fragments, or reduced to powder, and submerged and reconstructed. Land, in this view of the subject, loses its attribute of fixity. As a mass it might hold together in opposition to forces which the water freely obeys; but in its state of successive or simultaneous degradation, when disseminated through the water, in the state of sand or mud, it is subject to all the impulses of that fluid. In the lapse of time, then the protuberant land would be destroyed, and spread over the bottom of the ocean, filling up the lower parts, and tending continually to re-model the surface of the solid nucleus, in correspondence with the *form of equilibrium*. Thus after a sufficient lapse of time, in the case of an earth in rotation the polar protuberances would gradually be cut down and disappear, being transferred to the equator (as being *then* the *deepest sea*), till the earth would assume by degrees the form we observe it to have—that of a flattened *oblate* ellipsoid.

"We are far from meaning here to trace the process *by which* the earth really assumed its actual form; all we intend is to show that this is the form to which, under a condition of a rotation on its axis, it must *tend*, and which it would attain even if originally and (so as to speak) perversely constituted otherwise."

In this passage, the author (Sir J. Herschel), has contemplated the superficial effects of aqueous matter only; he might have added that every stream of lava which flowed out of a volcano would be impelled, in a slight degree, towards the equatorial regions, in obedience to the same power; and if the volcanic action should extend to great depths, so as to melt, one after another, different parts of the earth, the whole interior might at length be remodelled under the influence of similar changes, due to causes which may all be operating at this moment. The statical figure, therefore, of the terrestrial spheroid (of which the longest diameter exceeds the shortest by about twenty-five miles), may have been the result of gradual and even of existing causes, and not of a primitive, universal, and simultaneous fluidity.

Experiments made with the pendulum, and observations on the manner in which the earth attracts the moon, have shown that our planet is not an empty sphere, but that it must rather increase in density from the surface towards the centre; and it has also been inferred that the equatorial protuberance is continued inwards, that is to say, that layers of equal density are arranged elliptically, and symmetrically, from the exterior to the centre. The inequalities, however, in the moon's motion, on which this opinion is founded, are so extremely slight, that it can be regarded as little more than a probable conjecture.

The mean density of the earth has been computed by Laplace to be about $5\frac{1}{2}$, or more than five times that of water. Now the specific gravity of many of the metals range between that density and 21. Hence some have imagined that the terrestrial nucleus may be metallic—that it may correspond, for example, with the specific gravity of iron, which is about 7. But here a curious question arises in regard to the form which materials, whether fluid or solid, might assume, if subjected to the enormous pressure which they must obtain at the earth's centre. Water, if it continued to decrease in volume according to the rate of compressibility deduced from experiment, would have its density doubled at the depth of 93 miles, and be as heavy as mercury at the depth of 362 miles. Dr. Young computed that, at the earth's centre, steel would be compressed into one-fourth, and stone into one-eighth of its bulk. It is more than probable, however, that after a certain degree of condensation, the compressibility of bodies may be governed by laws altogether different from those which we can put to the test of experiment; but the limit is still undetermined, and the subject is involved in such obscurity, that we cannot wonder at the variety of notions which have been entertained respecting the nature and conditions of the central nucleus. Some have conceived it to be fluid, others solid: some have imagined it to have a cavernous structure, and have even endeavoured to confirm this opinion by appealing to observed irregularities in the vibrations of the pendulum in certain countries.

(To be continued.)

GLASS FROM BONES.

Glass may be made from calcined bones by digesting them during two or three days with half their weight of sulphuric acid, evaporating to dryness, and washing the residue in many different waters, until all the soluble matter is exhausted. The production of this effect is known by the water having no longer a yellow tinge.

The different waters thus used must then be brought together and evaporated to afford a solid extract. To separate the sulphate of lime contained in this, the extract must be dissolved in the least possible quantity of water, and filtered: the salt will then remain on the filter. This extract may be mixed with powdered charcoal, and distilled for the production of phosphorus; but if, instead of this, it be placed in a large crucible, and the fire is urged, it will at first swell considerably, but ere long will again settle, and at that instant the glass is made. This is white, and of a milky color.

These directions are taken from the System of Chemistry of M. Chaptal; who tells us that before his time Becher was perfectly well acquainted with the use to which bones could thus be applied, but that he concealed the process, on account of the abuse, which, according to his apprehensions, might be made of it, and to which he plainly enough alludes in the words—"Homo vitrum est, et in vitrum redigi potest; sicut et omnia animalia." This author was, nevertheless, led to express his regret that the Scythians, who drank from disgusting skulls, were not acquainted with the art of converting them into so cleanly a substance as glass;—and he also showed the possibility of forming a gallery of family effigies, moulded from glass, the produce of the identical bones of the originals, in which the likenesses might be preserved as truly as they now are by the limner. M. Chaptal adds, that a

skeleton of nineteen pounds weight may be made to yield five pounds of this phosphoric glass.

Newly-made glass of this description will emit very strong electric sparks, which will fly to the hand at the distance of two inches; but this property ceases after one or two days, however carefully the glass may be preserved from contact with the atmosphere. The substance is in fact phosphoric acid which has been deprived of its water, and which, if not carefully preserved from the atmosphere, it will again imbibe, becoming deliquescent. It has an acid taste, and is soluble in water.

ON THE COLORS OF NATURAL BODIES.

There is no branch of the application of optical science which possesses a greater interest than that which proposes to determine the cause of the colors of natural bodies. Sir Isaac Newton was the first who entered into an elaborate investigation of this difficult subject; but though his speculations are marked with the peculiar genius of their author, yet they will not stand a rigorous examination under the light of modern science.

That the colors of material nature are not the result of any quality inherent in the colored body has been incontrovertibly proved by Sir Isaac. He found that all bodies, of whatever color, exhibit that color only when they are placed in white light. In homogeneous *red*, in *violet* light *violet*, and so on for other colors. A *red* wafer, for example, appears red in the white light of day, because it reflects *red* light more copiously than any of the other colors. If we place a *red* wafer in *yellow* light, it can no longer appear red, because there is not a particle of red light in the yellow light which it could reflect. It reflects, however, a portion of yellow light, because there is some yellow in the red which it does reflect. If the *red* wafer had reflected nothing but pure homogeneous red light and not reflected white light from its outer surface, which all colored bodies do, it would in that case have appeared absolutely black when placed in yellow light. The colors, therefore, of bodies arise from their property of reflecting or transmitting to the eye certain rays of white light, while they stifle or stop the remaining rays. To this point the Newtonian theory is supported by infallible experiments; but the principal part of the theory, which has for its object to determine the manner in which particular rays are stopped, while others are reflected or transmitted, is not so well founded.

As Sir Isaac has stated the principles of his theory with the greatest clearness, we shall give them in his own words.

"1st, Those superficies of transparent bodies reflect the greatest quantity of light which have the greatest refracting power; that is, which separate media that differ most in their refracting power. And in the confines of equally refracting media there is no reflexion.

"2d, The least parts of almost all natural bodies are in some measure transparent; and the opacity of these bodies arises from the multitude of reflexions caused in their internal parts.

"3d, Between the parts of opaque and colored bodies are many spaces, either empty, or replenished with mediums of other densities; as *water* between the tinging corpuscles wherewith any liquor is impregnated; *air* between the aqueous globules that constitute clouds or mists; and for the most part *spaces*, void of both air and water, but yet perhaps not wholly void of all substance between the parts of all bodies.

"4th, The parts of bodies and their interstices must not be less than of some definite bigness to render them opaque and colored.

"5th, The transparent parts of bodies, according to their several sizes, reflect rays of one color, and transmit those of another, on the same grounds that thin plates or bubbles do reflect or transmit these rays; and this I take to be the ground of all their colors.

"6th, The parts of bodies on which their colors depend are denser than the medium which pervades their interstices.

"7th, The bigness of the component parts of natural bodies may be conjectured by their colors."

Upon these principles Sir Isaac has endeavoured to explain the phenomena of *transparency*, *black* and *white opacity* and *color*. He regards the transparency of *water*, *glass*, *salt*, *stones*, and such like substances, as arising from the smallness of their particles, and the intervals between them; for though he considers them to be as full of pores or intervals between the particles as other bodies are, yet he reckons the particles and their intervals to be too small to cause reflexion at their common surfaces. Hence it follows, that the particles of air and their intervals cannot exceed the half of a millionth part of an inch; the particles of water the $\frac{3}{8}$th of a millionth; and that those of glass the $\frac{1}{3}$d of a millionth: because at these thicknesses the light reflected is nothing, or the very black of the first order. The opacity of bodies, such as that of white paper, linen, &c., is ascribed by Newton to a greater size of the particles and their intervals, viz. such a size as to reflect the white, which is a mixture of the colors of the different orders. Hence in air they must exceed 77 millionths of an inch, in water 57 millionths, and in glass 50 millionths.

In like manner all the different colors in Newton's table are supposed to be produced, when the particles and their intervals have an intermediate size between that which produces transparency and that which produces white opacity. If a film of *mica*, for example, of an uniform *blue* color, is cut into the smallest pieces of the same thickness, every piece will constitute a mass of the same color.

So far the Newtonian theory is plausible; but in attempting to explain *black opacity*, such as that of coal and other bodies impervious to light, it seems to fail entirely. To produce blackness, "the particles must be less than any of those which exhibit color. For at all greater sizes there is too much light reflected to constitute this color; but if they be supposed a little less than is requisite to reflect the white and very faint blue of the first order, they will reflect so very little light as to appear intensely black." That such bodies will be black when seen by reflexion is evident; but what becomes of all the transmitted light? This question seems to have perplexed Sir Isaac. The answer to it is, "*it may perhaps be variously refracted to and fro* within the body, until it happens to be stifled and lost; by which means it will appear intensely black."

In this theory, therefore, *transparency* and *blackness* are supposed to be produced by the very same constitution of the body; *and a refraction to and fro* is assumed to extinguish the transmitted light in the one case, while in the other such a refraction is entirely excluded.

In the production of colors of every kind, it is assumed that the complementary color, or generally one half of the light, is lost by repeated reflexions. Now, as reflexion only changes the direction of light, we should expect that the light thus scattered would show itself in some form or other; but though many accurate experiments have been made to discover it, it has never yet been seen.

For these and other reasons, Dr. Brewster considers the Newtonian theory of colors as applicable only to a small class of phenomena, while it leaves unexplained the colors of fluids and transparent solids, and all the beautiful hues of the vegetable kingdom. He says, "in numerous experiments on the colors of leaves, and on the juices expressed from them, I have never been able to see the complementary color which disappears, and I have almost invariably found that the transmitted and the reflected tint is the same. Whenever there was an appearance of two tints, I have found it to arise from there being two differently-colored juices existing in different sides of the leaf. The Newtonian theory is, we doubt not, applicable to the colors of the wings of insects, the feathers of birds, the scales of fishes, the oxidated films on metal and glass, and certain opalescences."

The colors of vegetable life and those of various kinds of solids arise, we are persuaded, from a specific attraction which the particles of these bodies exercise over the differently-colored rays of light. It is by the light of the sun that the colored juices of plants are elaborated, that the colors of bodies are changed, and that many chemical combinations and decompositions are effected. It is not easy to allow that such effects can be produced by the mere vibration of an ethereal medium; and we are forced, by this class of facts, to reason as if light was material. When a portion of light enters a body, and is never again seen, we are entitled to say that it is detained by some power exerted over the light by the particles of the body. That it is attracted by the particles seems extremely probable, and that it enters into combination with them, and produces various chemical and physical effects, cannot well be doubted; and without knowing the manner in which this combination takes place, we may say that the light is *absorbed*, which is an accurate expression of the fact.

Now, in the case of water, glass, and other transparent bodies, the light which enters their substance has a certain small portion of its particles absorbed, and the greater part of it which escapes from absorption, and is transmitted, comes out colorless, because the particles have absorbed a proportional quantity of all the different rays which compose white light, or, what is the same thing, the body has absorbed white light.

(To be continued.)

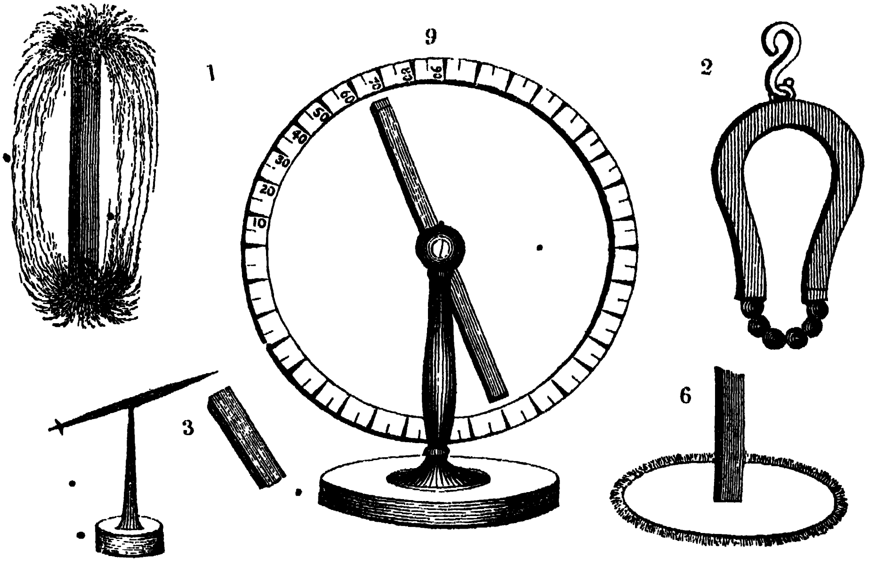
MISCELLANIES.

Colored Lithographic Printing.—A report has reached us of an extraordinary discovery, by Mr. Hullmandel, who has already done much to improve lithography, of a new mode of producing pictorial effects on lithographic stone by tints washed with a brush, like sepia drawing, which yield impressions so perfectly resembling original sketches, that the difference is not discernable. The painters, we are told, will now have at their command a means of multiplying their own works, which their habitual practice renders available, without altering their style of handling; for this new mode of lithography —or rather painting on stone—is just as if the sketch were made on stone instead of on paper. The variety and delicacy of the tints, the freedom and facility with which they are produced, and modified as well, and their durability under the printing process, are among the advantages attributed to this discovery, of which some trial specimens, by Mr. Harding, have been handed about privately, but not yet published—the patents by which Mr. Hullmandel has secured to himself the benefit of his invention not being yet completed.—*Athenæum.*

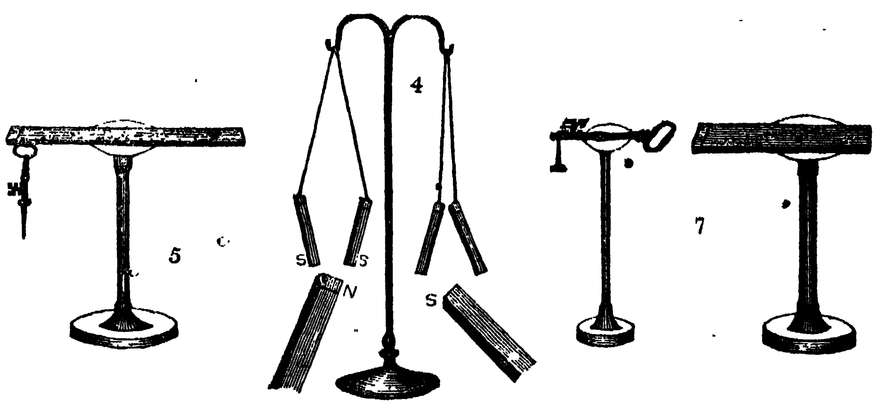
A New Musket.—The French papers give an account of experiments which have been making at Saint Etienne with a new musket, the invention of M. Philippe Mathieu. These muskets, called *fusils à six coups*, have, nevertheless, but a single barrel and a single lock. In form, they differ little from the common musket; the most perfect of which has, it is said, no advantage over them either in beauty or lightness. Their direction is more sure, and their danger to the bearer less. The six discharges are independent of each other; so that one, or more, may be made—and supplied by reloading separately—or the whole six charges may be fired off, one after the other, with surprising rapidity. One of these new muskets fired 8,000 charges, without effecting the slightest derangement of any part of the instrument.

Transparency of the Ocean.—Experiments were made during the voyage of the Coquille, to ascertain at what depth in the sea an apparatus became invisible, composed of a plank two feet in diameter, painted white, and weighted, so that on descending it should always remain horizontal. The results varied very much: at Offale, in the island of Waigiou, on the 13th September, the disc disappeared at the depth of fifty-nine feet; the weather calm and cloudy;—on the 14th, the sky being clear, it disappeared at the depth of 75.3 feet;—at Port Jackson, on the 12th and 13th of February, it was not visible at more than 38.3 feet in a dead calm; —the mean at New Zealand, in April, was 3.28 feet less;—at the Isle of Ascension, in January, under favorable circumstances, the extreme limits in eleven experiments were twenty-eight and thirty-six feet.

Respiration.—In ordinary respiration, 16 or 17 cubic inches of atmospheric air pass in the lungs 20 times in a minute, or a cubic foot every 5¼ minutes; 274 cubic feet in 20 hours, or a cube of 6½ feet each way. At each expiration, 1.375 of the oxygen is converted into carbonic acid gas; in 63 minutes a cubic foot, and nearly 23 feet in 24 hours. The loss of the air in bulk by respiration is but 0.12 per minute, or only the tenth of a foot in 24 hours. The nitrogen inspired and expired is exactly equal. If then the relative specific heat, or atomic motion of oxygen and carbonic acid, as the mean of Crawford and Dalton, be taken as 3.65 to 1, and the absolute heat of a cubic foot of oxygen as 876 deg., the difference between inspired oxygen and expired carbonic acid is 688 deg. for every foot in 63 minutes, 0.53 deg. by respiration, or 688 deg. + 23 = 55,824 deg. + 87.6 deg. or 15.911.6 deg. in all, for heat and strength in ordinary respiration per day.



MAGNETIC APPARATUS AND EXPERIMENTS.



PROPERTIES OF MAGNETISM.

We fully intended this week to begin a series of papers on electro-magnetic apparatus and principles; but find all explanations on that subject very unsatisfactory, and, indeed, scarcely to be understood—unless the reader be already acquainted with the chief facts and laws which regulate the natural and artificial magnet. It is, therefore, incumbent upon us, first, to give a paper upon this latter subject, in order that the other may come before us in a more intelligible form.

The *natural magnet*, or *load-stone*, contains a greater proportion of *iron* than any other iron ore, and is mixed with *silex*, *alumina*, and *sulphur*. Its specific gravity is about 7, and it generally appears of a brownish black color; but there are different species of it, which are found in different countries. The characteristics of *magnets*, both *natural* and *artificial*, are the same, and may be stated as follows:—

1. Magnets *attract iron* in its metallic state.
2. The magnetic fluid circulates from one end of them to the other—called, therefore, the *poles*. They possess a *directive power*, or *magnetic polarity*, which acts *horizontally*.
3. The opposite poles of magnets *attract* each other, but similar poles *repel* each other.
4. Magnets have a *vertical* motion, which is called *dipping*.
5. They are capable of *imparting* their power to *iron* or *steel*; to both, when hardened, *permanently*.

Of these properties, only the first and third were known to the ancients. With respect to the *directive power*, or *polarity* of the natural magnet, it may be observed, that magnets have sometimes more than two poles, owing to their heterogeneous nature and irregular figure; and the situation of the additional poles can be ascertained only by trial. When this is the case, the parts adjacent to a pole possess the contrary polarity, and the north and south poles are either *equal* in number, or differ by *one only*. Thus, there may be 4 south and 4 north poles, or 3 or 5 north to 4 south poles, &c. Magnets of the closest grain have the greatest power, and their attraction is strongest at the poles and in contact. In imparting the magnetic power to iron and steel, it is found that these substances, when *soft*, take the power more easily, but do not retain it so tenaciously as when *hard*.

Smaller pieces of the *natural magnet* are stronger, in proportion to their size, than larger ones, and a piece cut from a large magnet will sometimes possess greater power than the magnet from which it has been separated, owing to the power being stronger in one part than another. Sir I. Newton had a magnet, weighing only 3 grains, which he wore in his ring, and which was capable of lifting 746 grains, or nearly 250 times its own weight.

These general remarks being premised, we shall now consider more in detail, and illustrate the five laws just mentioned as those which regulate and cause all magnetic appearances.

First.—Magnets attract iron in its metallic state. This every person who has ever lifted a needle by a magnet is aware of—and numerous magnetic toys are constructed upon this principle; for example, the floating swan which comes to be fed, contains a needle—and the bread conceals a small magnet. The fish which is caught by a large magnetic hook is also furnished with a needle or wire, which passing through its body serves as an attractive to the magnet.

This fact is of extreme use to numerous artizans—particularly brass founders, who by plunging an artificial magnet into brass filings, or clippings, are enabled readily to separate from them any particles of iron which may be present, and which, if suffered to remain, would injure their work, and impede its fusion in the melting pot.

It is not merely that a magnet will take up a single piece or particle of iron—but in proportion to its strength it will attach to itself a considerable number of particles, and the particular mode in which these arrange themselves shows most of the laws of magnetism. To show this experiment in the best and most conclusive manner lay upon the table a straight magnet, as in Fig. 1. Lay upon this a sheet of white paper, and sprinkle over the paper gently and regularly some iron or steel filings. They will be seen to assume the form represented in the Figure,—collecting themselves in multitudes around the two ends of the instrument, and then forming more or less perfect curved lines, from one of these parts to the other.

From this experiment four things are evident.—1st. That a magnet attracts iron.—2nd. That it attracts it more particularly at the two ends—which are therefore called poles.—3rd. That when it has attracted one particle, it communicates a power to that which enables it to attract other particles; for it is seen, that the filings are connected with each other, quite as much as with the chief magnet.—And, 4th. That the magnetic fluid circulates from one pole to the other of a magnet or metallic substance subjected to its influence. All these facts are also seen in the following experiment, where a horse-shoe magnet is used, and the circulation from one pole to the other shown by larger bodies.

Ex. 2.—Let Fig. 2, be a strong horse-shoe magnet, suspended by a hook; have ready some small iron balls, (in the absence of these, needles or nails will do,) hold one ball to one pole, it will of course adhere; then hold a ball to the other pole, that will adhere also. In this manner continue to add one ball at a time to the poles alternately, and it will be seen that the balls of one side will gradually approach those of the other, until when a sufficient number has been thus suspended they will touch each other, forming a bow beneath the magnet.

A question now arises, why it is that the balls approach and coalesce? This is because they have each become a magnet, and although previously they showed of themselves no power, yet now that they are in contact with a magnet, they partake and communicate the properties which their position gives them. Every magnet has poles, called, for reasons which we shall afterwards consider, the north pole and the south pole. These are contrary to each other, and using the terms which we have already used in electricity, we may say that one of them has a deficiency, or is *minus*, or *negatively* magnetised. The other has a superabundance, or may be considered as *positive*. Though, be it observed, that these terms are not used in magnetism, nor do we know that such is the state of these parts, but they are here alluded to, to show by analogy with another science intimately connected with magnetism, the differences of the poles.

To show the law of attraction, we must consider the effect of magnets upon each other, as by trial we shall find that when two magnets are held near together, there will be attraction in some part, and repulsion in others, as follows:—

Ex. 3.—Suspend a straight bar magnet either upon a point, or else hang it up by a string, or in any other way that it may have freedom of motion. The north pole of this magnet will be known by its pointing towards the northern part of the world; and, as in all artificial magnets, will most likely have a file mark made across it to distinguish this end, as will also be the case with the other magnets used for experiment. Now hold near the north end of this, the north end of another magnet, and repulsion will take place. (See Fig. 3.) Hold then the south end of the magnet which is in the hand to the south end of that which is suspended, and repulsion will again take place. Thus like poles repel each other. Reverse the magnet in the hand, or hold it to the first, so that the south pole of one be opposite the north pole of the other, and attraction will be perceptible. Hold either end of the magnet to the middle of the other, and it will attract it, and probably lift it up, not because it is a magnet, but because the upper magnet, being equally distant from either pole, is not attracted particularly to either, but lifts up the suspended magnet merely as it would a piece of iron or steel. Another law is, therefore, established, that like poles repel each other, and contrary poles attract each other, and did space allow, it might be proved that the degree of attraction and repulsion is inversely as the square of the distance between them—that is, if the attractive power at one inch distance, be one the attraction at two inches will be a quarter, at three inches a ninth, at four inches a sixteenth part of one, and so on.

Ex. 4.—If two magnets be hung up on strings parallel and close to each other, the north pole of each being uppermost, they will retire from, or repel each other, though they still remain parallel, because north repels north, and south repels south, and as at the centre there is no counter-action, the magnets will wholly recede from each other. If now another magnet be held towards them, they will lose their parallelism, and according to circumstances will take one of the two forms seen in Fig. 4.

The next property to be discussed is magnetic *induction*. It has been seen in experiments 1 and 2, in the attraction of the iron filings in the one instance, and in the balls in the other. The following will render the subject plainer:

Ex. 5.—Let a magnet be laid upon a stand or table, and offer an iron key to the north pole, it will, as we have before seen, be attracted, and remain attached to it. Its approach to the magnet has in truth changed the nature of the key; it has become magnetic itself, and capable of attracting other iron bodies near it. Try this by presenting a nail to the key, it will hold on likewise, and if the original magnet be strong enough, three or four may be suspended in the same manner—this effect is produced by induction. The fluid in the magnet affects that in the key, and *induces* it to arrange itself so as to be collected in two poles, so that in the case now supposed, the south pole of the key is uppermost, its north pole downwards; this acts in like manner upon the nail, making it to have a south pole upwards and a north pole downwards also. If the key had been at first presented to the other end of the magnet, its north pole, and also that of the nail, would have been upwards, instead of downwards. (See Fig 5.)

Another important law then is established—that a magnet has the power of rendering iron and steel magnetic by induction; and that this induction is always consistent with the law of magnetic attraction and repulsion. One pole always attracting to itself the fluid which belongs to the contrary pole in the other body.

A curious effect of induction is seen when a powerful magnet is made to take up a round plate of iron—of course, one pole of this round plate will be at the centre, where it is held up. The other pole is in no particular part of the iron; but the effect is scattered all round—weaker than if the poles were concentrated to a single point, but sufficiently strong to attract needles, iron filings, &c. (See Fig. 6.)

It is not necessary, in order that induction should take place, that the key should touch the magnet. The effect will be the same, though lessened in degree, if lying some little distance off; and even if a neutral body lie placed between them.

Ex. 5.—Place a large magnet on a stand, as in a former experiment, and the key on another stand, so that half an inch or more space intervene; now hold the nail to the key and it will be attracted as before. (See Fig. 7.)

This will account for magnetic *polarity*. If a magnet be so placed, or suspended, as to have an opportunity of moving horizontally, it will, as is well known, continue to turn round until it has reached a certain position to the north magnetic pole of the earth, or as we usually say, it points north and south. The reason of this is evidently an attraction towards that point. Why there should be this attraction we may afterwards consider, it is only requisite now to state the fact—a fact, indeed, of greater importance than any other in science, as from this property the mariner is enabled to direct his course with certainty and confidence over the trackless ocean, by means of the compass needle. When a needle is suspended, it will be seen that it is the marked end of it which is directed northwards, whereas, it ought to be the south end northwards, because from the law of attraction the north pole of the earth's magnet—supposing one, should have a south pole nearest to it; and so it has, but long habit, and general custom assigned the name north pole to that end of a magnet which was directed towards the north; and, although the term is evidently erroneous, yet, as it is only an error of a word—and that error universally known to the philosopher, it has not been thought advisable to change it; because by so doing a very considerable inconvenience would for a long time be occasioned,—therefore, practically speaking, the north pole is towards the north pole of the earth—but scientifically, the south pole.

The next property of the magnet is its *dip*, that is a tendency for one end of it to sink lower than the other—for example, look at Fig. 8. This represents a long magnet and five small suspended magnets in various directions about it. The centre one hangs horizontally—its poles are equally attracted to either pole; but remove it near one end, and the contrary pole of the little magnet will *dip*, or be attracted downwards—take it quite to the end and it will stand perpendicular. Thus it is in nature, a compass needle at the equator is horizontal—as it proceeds northwards over the north magnetic pole, it becomes perpendicular, as in the experiment alluded to. Were the compass carried along a meridian in a southern hemisphere the same takes place; but with the contrary pole. Fig. 9.

represents a dipping needle of a simple construction in which this deviation may be readily observed.

Such is a comprehensive outline of the general facts relative to the powers and properties of magnetism, and sufficient to enable us to proceed with electro-magnetism another time.

CAUTION TO ELECTROTYPISTS.

Although we do not profess to treat of medical subjects, yet as the following is so nearly connected with a matter that has occupied much of our attention, and moreover conveys a valuable caution, we hope that we shall be excused for going beyond our proper sphere in inserting it. It is copied from "The Chemist," and written by *Mr. J. P. Simon*, M.D., of Dover.

"Within the last two months, I have been engaged in a series of experiments in the new art of electrotype, and in that short space of time, I have dissolved not less than thirty pounds' weight of sulphate of copper. In all my former experiments, I did not experience any apparent ill effect from the absorption of that salt into my system; but whether it was owing to the smallness of my surgery (or rather factotum laboratory) in which all my electrotype experiments are conducted, or to my being like the rest of my nation, French, of rather a restless and impatient nature, and in consequence of this impatience, pouring hot water on the blue vitriol, and in order to hasten its solution stirring it about until nearly ready for use, I know not. Of course, during that process, I inhaled the copper vapour in quite sufficient quantity to curdle any sweet milk I might have had in my stomach. Yet I was perfectly unmindful of that, and not being afraid to put my finger in the pie, as they say, I would often make use of the forceps of Adam instead of a glass stick, and at length I began to feel uneasiness between my shoulders, with head-aches, (to which I am not subject) shivering, and occasional pain in the epigastric region. I am naturally yellow, but I became pale, and experienced what the French call "vertigo," with prostration of strength and dimness of sight; but this is not all; the nervous papillæ of the tongue became tumefied and horribly annoying. I first thought that I had scalded my tongue with a mouthful of hot broth, and I armed myself with patience in the hope that time would relieve the inconvenience, but it was not so; the evil increased rather than abated, and the tongue became ulcerated in the centre, and considerably swollen on each side; and it was furred as if a "tartine" of spermaceti ointment had been nicely spread over it; the fauces also became tumefied and inflamed, while the soft palate, or roof of the mouth, became coated with petechiæ, resembling the measles; and with that tumefied gums and slight ptyalism. Being also engaged in Daguerrotype experiments, I thought of attributing all this to the influence of iodine, which I also freely handled.

"I was at last obliged to suspend my experiments, and use all possible remedies to restore my impaired health. Having probably and fortunately escaped the deleterious effects of copper, I thought I might renew my experiments, and although I had observed that after having washed my hands three or four times the water became blue from the system being contaminated with that mineral, yet I was more inclined to think I was under the influence of iodine rather than copper, although I often felt a copperish, cold, subacid taste, particularly in opening my mouth to inspire fresh air, the oxygen of which, perhaps, formed with it an instantaneous oxide of copper, communicated to the gustatory nerves, or nerves of taste. I dissolved only two or three pounds of the salt of copper in the usual way, and on the second day of my electro-chemical amusement I began to feel head-ache, and uneasiness about the fauces and soft palate; first, the affection appeared on the tip of the tongue, but now it showed itself as above.

"With considerable itchiness, and feeling all of a sudden as if I was going to faint, I opened my surgery window, and, for the first time, I felt convinced I was labouring under the influence of that poisonous mineral. I then looked in my mouth and *saw* and *felt* that the just lost complaint was fast returning. I washed my hands, and *three* times the water in the basin became blue. I then determined on using more caution, regretting only the necessity of taking antidotes, one of which was pleasant enough, viz. syrups in quantities, according to the celebrated Orfila. But the physicky part I do not much like, for though I may like to prescribe a large dose to my neighbour, I like it better for him than for myself.

"Should the above lines deserve your notice, as tending to prolong the lives of your scientific readers, pray insert it, and that I am yet spared to relate to you my very fortunate escape, thanks be to Providence."

SHAPE AND HEAT OF THE EARTH.

(*Resumed from page 286, and concluded.*)

Central Heat.—The hypothesis of internal fluidity calls for the more attentive consideration, as it has been found that the heat in mines augments in proportion as we descend. Observations have been made, not only on the temperature of the air in mines, but on that of the rocks, and on the water issuing from them. The mean rate of increase, calculated from results obtained in six of the deepest coal mines in Durham and Northumberland, is 1° Fahr. for a descent of forty-four English feet. A series of observations, made in several of the principal lead and silver mines in Saxony, gave 1° Fahr. for every sixty-five feet. In this case, the bulb of the thermometer was introduced into cavities purposely cut in the solid rock at depths varying from two hundred to above nine hundred feet. But in other mines of the same country, it was necessary to descend thrice as far for each degree of temperature.

A thermometer was fixed in the rock of Dolcoath mine, in Cornwall, by Mr. Fox, at the great depth of 1380 feet, and frequently observed during eighteen months; the mean temperature was 68° Fahr., that of the surface being 50°, which gives 1° for every seventy-five feet.

Kupffer after an extensive comparison of the results in different countries, makes the increase 1° F. for about every thirty-seven English feet; and Cordier considers that it would not be overstated at 1° Cent. for every twenty-five metres, or about 1° Fahr. for every forty-five feet.

Some writers have endeavoured to refer these phenomena (which, however discordant as to the ratio of increasing heat, appear all to point one way), to the condensation of air constantly descending from the surface into the mines. For the air under pressure would give out latent heat, on the

same principle as it becomes colder when rarified in the higher regions of the atmosphere. But, besides that the quantity of heat is greater than could be supposed to flow from this source, the argument has been answered in a satisfactory manner by Mr. Fox, who has shown, that in the mines of Cornwall the ascending have generally a higher temperature than the descending aërial currents. The difference between them was found to vary from 9° to 17° Fahr.: a proof, that instead of imparting heat, these currents actually carry off a large quantity from the mines.

If we adopt M. Cordier's estimate of 1° Fahr. for every 45 feet of depth as the mean result, and assume, with the advocates of central fluidity, that the increasing temperature is continued downwards, we should reach the ordinary boiling point of water at about two miles below the surface, and at the depth of about twenty-four miles should arrive at the melting point of iron, a heat sufficient to fuse almost every known substance. The temperature of melted iron was estimated at 21,000° Fahr., by Wedgwood; but his pyrometer gives, as is now demonstrated, very erroneous results. It has been ascertained by Professor Daniell, that the point of fusion is 2716° Fahr.

By adopting the least correct of these two results the melting point of our ordinary rocks would be farther removed from the surface; but this difference does not affect the probability of the theory now under consideration. In either case, we must be prepared to maintain, that a temperature many times greater than that sufficient to melt the most refractory substances known to us, is sustained at the centre of the globe; while a comparatively thin crust, resting upon the fluid, remains unmelted; or is even, according to M. Cordier, increasing in thickness, by the continual addition of new internal layers solidified the process of refrigeration.

The mathematical calculations of Fourier, on the passage of heat through conducting bodies, have been since appealed to in support of these views; for he has shown that it is compatible with theory that the present temperature of the surface might coexist with an intense heat, at a certain depth below. But his reasoning seems to be confined to the conduction of heat through solid bodies and the conditions of the problem are wholly altered when we reason about a fluid nucleus, as we must do, if it be assumed that the heat augments from the surface to the interior, according to the rate observed in mines. For when the heat of the lower portion of a fluid is increased, a circulation begins throughout the mass, by the ascent of hotter, and the descent of colder currents. And this circulation, which is quite distinct from the mode in which heat is propagated through solid bodies, must evidently occur in the supposed central ocean, if the laws of fluids and of heat are the same there as upon the surface.

In Mr. Daniell's recent experiments for obtaining a measure of the heat of bodies, at their point of fusion, he invariably found that it was impossible to raise the heat of a large crucible of melted iron, gold, or silver, a single degree beyond the melting point, so long as a bar of the respective metals was kept immersed in the fluid portions. So in regard to other substances, however great the quantities fused, their temperature could not be raised while any solid pieces immersed in them remained unmelted; every accession of heat being instantly absorbed during their liquefaction. These results are, in fact, no more than the extension of a principle previously established, that so long as a fragment of ice remains in water, we cannot raise the temperature of the water above 32° Fahr.

If, then, the heat of the earth's centre amount to 450,000° Fahr., as M. Cordier deems highly probable, that is to say. about twenty times the heat of melted iron, even according to Wedgwood's scale, and upwards of 160 times according to the improved pyrometer, it is clear that the upper parts of the fluid mass could not long have a temperature only just sufficient to melt rocks. There must be a continual tendency towards a uniform heat; and until this were accomplished, by the interchange of portions of fluid of different densities, the surface could not begin to consolidate. Nor, on hypothesis of primitive fluidity, can we conceive any crust to have been formed until *the whole* planet had cooled down to about the temperature of incipient fusion.

It cannot be objected that hydrostatic pressure would prevent a tendency to equalization of temperature; for, as far as observations have yet been made, it is found that the waters of deep lakes and seas are governed by the same laws as a shallow pool; and no experiments indicate that solids resist fusion under high pressure. The arguments, indeed, now controverted, always proceed on the admission that the internal nucleus is in a state of fusion.

It may be said that we may stand upon the hardened surface of a lava current while it is still in motion,—nay, may descend into the crater of Vesuvius after an eruption, and stand on the scoriæ while every crevice shows that the rock is red-hot two or three feet below us; and at a somewhat greater depth, all is, perhaps, in a state of fusion. May not, then, a much more intense heat be expected at the depth of several hundred yards, or miles? The answer is,—that, until a great quantity of heat has been given off, either by the emission of lava, or in a latent form by the evolution of air and gas, the melted matter continues to boil in the crater of a volcano. But ebullition ceases when there is no longer a sufficient supply of heat from below, and then a crust of lava may form on the top, and showers of scoriæ may then descend upon the surface, and remain unmelted. If the internal heat be raised again, ebullition will recommence, and soon fuse the superficial crust. So in the case of the moving current, we may safely assume that no part of the liquid beneath the hardened surface is much above the temperature sufficient to retain it in a state of fluidity.

It may assist us in forming a clearer view of the doctrine now controverted, if we consider what would happen were a globe of homogeneous composition placed under circumstances analogous, in regard to the distribution of heat, to those above stated. If the whole planet, for example, were composed of water covered with a spheroidal crust of ice fifty miles thick, and with an interior ocean having a central heat about two hundred times that of the melting point of ice, or 6400° Fahr.; and if, between the surface and the centre, there was every intermediate degree of temperature between that of melting ice and that of the central nucleus;—could such a state of things last for a moment? If it must be conceded, in this case, that the whole spheroid would be instantly in a state of violent ebullition, that the ice (instead of being strengthened annually by new internal layers) would soon melt, and form part of an atmosphere of steam—on what

principle can it be maintained that analogous effects would not follow, in regard to the earth, under the conditions assumed in the theory of central heat?

M. Cordier admits that there must be tides in the internal melted ocean; but their effect, he says, has become feeble, although originally, when the fluidity of the globe was perfect, the rise and fall of these ancient land tides could not have been less than from thirteen to sixteen feet. Now granting, for a moment, that these tides have become so feeble as to be incapable of lifting up every six hours the fissured shell of the earth, may we not ask whether, during eruptions, jets of lava ought not to be thrown up from the craters of volcanos, with the tides?—and whether the same phenomena would not be conspicuous in Stromboli, where there is always lava boiling in the crater? Ought not the fluid, if connected with the interior ocean, to disappear entirely on the ebbing of its tides?

CHEMICAL TESTS.

(*Resumed from page* 248.)

Sulphurous Acid Gas and Ammonical, Tests for each other.—Open two phials, one containing sulphurous acid, and the other water of ammonia; and bring them near to each other. The vapours will combine, forming a white cloud, which presently will be precipitated on the glass in a solid state, forming *sulphate of ammonia.*

Nitric Acid a Test for Steel.—Let fall a single drop of nitric acid on any cutting or other instrument supposed to be steel. If steel, the part whereon the drop fell will immediately turn black. No effect will for a considerable time take place, if nitric acid is dropped on pure iron. The blackening of the steel is owing to the combination of its iron with the acid, and the consequent precipitation of the carbon.

Mode of Detecting Chalk in combination with White Lead.—White oxide of lead is often adulterated by the carbonate of lime: to detect this, pour over a dram of the suspected oxide, four drams of pure acetous acid. This will dissolve both oxide and chalk, but if a few drops of a solution of oxalic acid be now poured in, a very abundant white precipitate of oxalate of lime will take place.

Test of the Purity of Calomel. — The specific gravity of calomel is a very good test to distinguish it from other white powders, as it is much heavier than any of them: but the most unequivocal test is by rubbing some of the powder in a mortar with some pure ammonia; or by shaking it in a phial with lime-water. In either of these cases, if the sub-muriate is present and in a pure state, the combination will become *intensely black.*

Test for Carbonic Acid.—Into any mineral, or other water, suspected to hold carbonic acid in solution, either alone or in combination with another substance, let fall one drop of sulphuric acid, at the same time stirring the liquid. A slight effervescence occasioned by the ascension of small globules of carbonic acid gas will take place, if any of this acid has been held in combination.

Tests for the Adulteration of Essential Oils.—Essential oils are often adulterated by alcohol, also by fixed and essential oils of cheaper price. To detect alcohol, pour two drams of distilled water into a dram of the suspected oil: the whole will become milky if alcohol be present. To detect fixed oils, as almond and olive oil, let a drop of the suspected oil fall on a piece of writing paper, and hold it near the fire: if the whole evaporates, and leaves no stain upon the paper, there is no fixed oil present; but if a stain remains, that is, if the part where the drop fell appears greasy or transparent, the essential oil has been adulterated either by almond, or by olive oil.

Tests for the Adulteration of Mercury.—Dissolve a small quantity of the suspected mercury in as much nitric acid as will saturate it, divide this solution in three wine glasses, and into the first pour some distilled water; if a white precipitate is thrown down, it is an indication of the presence of bismuth. Into the second, pour water saturated with sulphuretted hydrogen gas, and a brown precipitate will discover the presence of even the smallest quantity of lead. Tin is known to exist in union with mercury, by dropping in the third glass nitro-muriate of gold, a little diluted, when a purple precipitate will take place.

Gallic Acid in the Oak Apple.—Pluck from an oak tree, one of those excrescences called *oak apple*, and whilst fresh, cut it in two, by a table or penknife. Let the moisture dry upon the blade, and on inspection it will be found covered with a black fluid, in every respect like writing ink. If the apple be examined, a like appearance may be observed on each of the cut surfaces. In this experiment, the gallic acid, existing plentifully in the apple, combines with the iron, forming gallate of iron.

Tests for Volatile Acids.—If a liquid is suspected to contain any uncombined volatile acid, such as the sulphurous, nitrous, muriatic, carbonic or acetic, it is merely necessary to hold over the vessel containing it, a slip of paper previously dipped in liquid ammonia. If any of these acids exist in the solution, their gaseous or volatile particles will combine with the vapour of the ammonia, and form a solid salt.

Test for Chalk in the Adulteration of Magnesia.—On account of adding to its weight, magnesia is very often adulterated by chalk. To discover this imposition, put some carbonate of magnesia into a tumbler, and pour over it some diluted sulphuric acid, as long as a discharge of carbonic acid gas, by effervescence, take place. If the whole is now quite limpid, and no white powder remains, the magnesia has been free from adulteration, but if this be the case, it has been adulterated by powdered chalk.

To ascertain the Purity of Black Sulphuret of Mercury. — For fraudulent purposes, this article is very often adulterated by ivory black: and to detect the imposition, nothing more is necessary than to put about a dram of it on a shovel and to hold it over the fire; if the sulphuret is pure, the whole be volatilised, if not, ivory black is present. To ascertain whether the mercury and sulphur are properly combined, rub a small quantity on a piece of gold; and if the gold be whitened like silver on the part rubbed, the mercury is not properly combined, but exists in the state of very minute globules. If on the contrary, it leaves no mark, it is well combined with the sulphur. The white stain is caused by the affinity existing between gold and mercury.

Tests to detect the Adulteration of Vermillion.—Red sulphuret of mercury, or vermillion, is often adulterated by the red oxide of lead, chalk, and a substance known by the name of dragon's blood. To detect these, put a small portion of the vermillion into three wine glasses: into one of these pour a little alcohol, if dragon's blood exist in it, the al-

cohol will be slightly tinged of a red color; in a few days, if shaken in a phial it will be quite red, or if held over a lamp in a Florence flask, the alcohol will soon acquire a deep color.

Into another of the glasses pour some pure acetous acid, if chalk be present, effervescence will be the consequence; but as a further test, pour the clear liquid into another glass, and add a solution of oxalic acid; in this case, a white precipitate of oxalate of lime will fall down. To detect red lead, pour some acetous acid into the third glass and decant the liquor: into this pour some Harrowgate water; if lead exists in it, a black precipitate will fall down. A further test for lead is a solution of the sulphate of soda; this will cause a white precipitate of sulphate of lead.

Tests for Hydrogen in Sulphur.—Sir H. Davy proved the existence of hydrogen in sulphur, as follows:—a bent glass tube, having a platinum wire hermetically sealed into its upper extremity, was filled with sulphur. This was melted by heat, and a proper connection being made with the voltaic apparatus of five hundred double plates, each six inches square, and highly charged, a most intense action took place. A very brilliant light was emitted; the sulphur soon entered into ebullition; elastic matter was evolved in great quantities; and the sulphur from being of a pure yellow, became of a dark reddish brown tint. The gas was found to be sulphuretted hydrogen, or hydrogen gas holding sulphur in solution; and its quantity, in about two hours, was more than five times the volume of the sulphur employed.

(To be continued.)

THE DIAMOND.

The purest form of the elementary substance, carbon, is the diamond, a mineral body first discovered in Asia, in the provinces of Golconda and Visapour, in Bengal, and in the island of Borneo. About the year 1720, diamonds were first found in the district of Serra Dofrio, in Brazil, and from this locality the European market is now chiefly supplied. They occur in detached crystals in alluvial soil; though it appears probable from a specimen described by Mr. Heuland, (*Geol. Trans.*, 2nd series, i. 419,) that in Brazil the real matrix is an ironstone which forms beds resting on primary chlorite slate. According to Mr. Voysey, the diamonds of the Nalla Malla Mountains, in Hindostan, are found in a species of pudding-stone or breccia, composed of fragments of jasper, quartz, and calcedony. (*Phil. Mag.*, 2nd series, i. 147.) The primitive form of the diamond is the regular octoëdron, each triangular facet of which is sometimes replaced by six secondary triangles bounded by curved lines: so that the crystal becomes spheroidal and presents forty-eight facets. Diamonds, with twelve and twenty-four facets, are not uncommon. The diamond has been found nearly of all colors: those which are colorless are most esteemed; then those of a decided red, blue, or green tint. Black diamonds are extremely rare. Those which are slightly brown, or tinged only with other colors, are least valuable.

The fracture of the diamond is foliated, its laminæ being parallel to the sides of a regular octoëdron. It is very brittle and very hard; its specific gravity varies from 3.4 to 3.6, it is most commonly 3.52. It is a non-conductor of electricity, frequently phosphorescent, and has a very high refractive power in regard to light, as compared with its density.

The art of cutting and polishing diamonds, though probably of remote antiquity in Asia, was first introduced into Europe in 1456 by Louis Berghen of Bruges, who accidentally discovered, that, by rubbing two diamonds together, a new facet was produced. The particular process of forming the rough gems into *brilliants* and *rose diamonds* has been described at length by Jeffries. By either of these processes, but especially by the former, so much is cut away, that the weight of the polished gem does not exceed half that of the rough stone; so that the value of a brilliant-cut diamond is esteemed equal to that of a similar rough diamond of twice the weight, exclusive of the cost of workmanship. The weight, and therefore the value of diamonds, is estimated in *carats*, 150 of which are about equal to one ounce troy, or 480 grains. They are divided into halves, quarters, or carat grains, eighth, sixteenth, and thirty-second parts.

The difference of value between one diamond and another of equal merit, is, generally speaking, as the squares of their respective weights: thus, the value of three diamonds, of one, two, and three carat's weight respectively, is as one, four, and nine. The average price of rough diamonds, is estimated by Jeffries at 2*l.* per carat; and, consequently, when wrought, the cost of the first carat, exclusive of workmanship, will be 8*l.* which is the value of a rough diamond of two carats.

A wrought diamond of 3 carats is worth....	£72
,, 4 ditto..........	120
,, 5 ditto..........	200
,, 10 ditto..........	800
,, 20 ditto..........	3,200
,, 30 ditto..........	7,200
,, 40 ditto..........	12,000
,, 50 ditto..........	20,000
,, 60 ditto..........	28,800
,, 100 ditto..........	100,000

This mode of valuation, however, only applies to small diamonds, in consequence of the difficulty of finding purchasers for the larger ones.

The largest known diamond is probably that mentioned by Tavernier, in the possession of the Great Mogul. Its size is about that of half an hen's egg; it is cut in the rose form, and when rough, is said to have weighed 900 carats. It was found in Golconda about the year 1550. Among the crown jewels of Russia is a magnificent diamond, weighing 195 carats. It is the size of a small pigeon's egg, and was formerly the eye of a Brahminical idol, whence it was purloined by a French soldier; it passed through several hands, and was ultimately purchased by the Empress Catherine, for the sum of 90,000*l.* in ready money, and an annuity of 4,000*l.* Perhaps the most perfect and beautiful diamond hitherto found, is a brilliant brought from India by an English gentleman of the name of Pitt, who sold it to the Regent Duke of Orleans, by whom it was placed among the jewels of France. It weighs rather more than 136 carats, and was purchased for 100,000*l.* In the year 1828, a collection of diamonds of extraordinary size and beauty was in the possession of Messrs. Rundell, Bridge, and Co., of London: the suite consisted of eight, of various shapes and sizes, the smallest weighing 55 grains, and the largest 151 grains: with one exception they were all brilliant cut

BUILDING CEMENTS.

BUILDING cements consist of certain burnt or vitrified earths, and metallic and other substances, which are pounded or ground to powder, and mixed with lime.

The earthy substances used, are all those kinds of clay or loam that are capable of becoming vitrified and intensely hard, by exposure to a strong fire; chalk, and such earths as become soft and fall to pieces, when exposed to heat, are unfit for the purpose; but flint stones and pebbles may be used with advantage.

The proper kinds of earth being thus selected, the material is heated in the interior of a brick-kiln, or furnace, until it becomes completely vitrified or reduced to a state of hard, black, or glossy clay, and this vitrification will sometimes be improved, by mixing refuse, or broken glass, or sand and wood-ashes, with sand or vitrified materials, such as those which come from the furnaces of smelting-houses, glass-houses, foundaries, &c., or any materials reduced to a state of vitrification by intense heat. These materials are then to be bruised, pounded, or ground, and sifted through a wire sieve, until reduced to such a state of fineness as may be proper for mixing up as a plaster. Thus prepared, the materials are to be sorted into different qualities, and put up for use.

To make Hamelin's Cement.—This cement consists in a mixture of earths and other substances that are insoluble in water, or nearly so, either in their natural state, or such as have been manufactured, as earthenware, porcelain, and such like substances; but Mr. H. prefers those earths that, either in their natural or manufactured state are the least soluble in water, and have, when pulverized or reduced to powder, the least color. To the earth or earths, as before named, either in their natural or manufactured state, and so pulverized, he adds a quantity of each or the oxyds of lead, as litharge, grey oxyd, and minium, reduced or ground to a fine powder, and to the whole of the above-named substances, a quantity of pulverized glass or flint stone, reduced to a pulverized state, in proper and due proportion of vegetable oil, form and make a composition or cement, which, by contact or exposure to the atmosphere, hardens and forms an impenetrable and impervious coating or covering, resembling Portland or other stones.

To any given weight of the earth or earths, commonly called pit-sand, river-sand, rock-sand, or any other sand of the same or the like nature, or pulverized earthenware or porcelain, add two-thirds of such given weight of the earth or earths, commonly called Portland stone, Bath stone, or any other stone, of the same or the like nature pulverized. To every five hundred and sixty pounds weight of these earths, so prepared, add forty pounds weight of litharge, and, with the last mentioned given weights, combine two pounds weight of pulverized glass or flint stone. Then join to this mixture one pound weight of minium and two pounds weight of grey oxyd of lead.

This composition being thus mixed, pass the same through a wire sieve, or dressing machine, of such a fineness or mash as may be requisite for the purposes it is intended for, preferring a fine sieve, mash, or wire-work, when the composition is to be used for works that require a fine smooth or even surface. It is now a fine and dry powder, and may be kept open in bulk or in casks for any length of time, without deterioration.

When this composition is intended to be made into cement, for any of the purposes described, it is spread upon a board or platform, or mixed in a trough; and to every six hundred and five pounds weight of the composition, are added five gallons of vegetable oil, as linseed oil, or walnut oil. The composition is then mixed in a similar way to that of mortar, and is afterwards subjected to a gentle pressure, by treading upon it; and this operation is continued until it acquires the appearance of moistened sand. The mixture, being thus composed, is a cement fit and applicable to the enumerated purposes. It is requisite to observe, that this cement should be used the same day the oil is added, otherwise it will fix or set into a solid substance.

To make Cement for Floors.—Earthen floors are commonly made of loam, and sometimes, especially to make malt on, of lime and brook sand, and gun dust or anvil dust from the forge. The manner of making earthen floors for plain country habitations is as follows:—Take two-thirds of lime, and one of coal ashes well sifted, with a small quantity of loam clay: mix the whole together, and temper it well with water, making it up into a heap; let it lie a week or ten days, and then temper it over again. After this, heap it up for three or four days, and repeat the tempering very high till it become smooth, yielding, tough, and gluey. The ground being then levelled, lay the floor therewith about $2\frac{1}{2}$ or 3 inches thick, making it smooth with a trowel: the hotter the season is, the better; and when it is thoroughly dried, it will make the best floor for malt-houses. If any one would have their floors look better, let them take lime of rag-stones, well-tempered with whites of eggs, covering the floor about $\frac{1}{2}$ an inch thick with it, before the under flooring is too dry. If this be well done, and thoroughly dried, it will look, when rubbed with a little oil, as transparent as metal or glass. In elegant houses, floors of this nature are made of stucco, or of plaster of Paris beaten and sifted, and mixed with other ingredients.

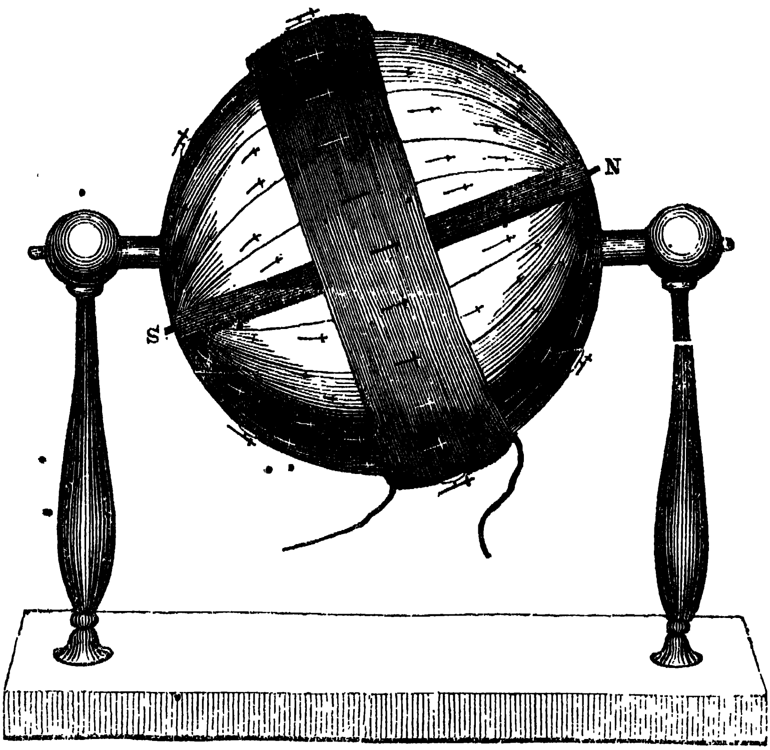
To make Cement for Canals.—Take 1 part of iron filings, reduced to sifted powder; 3 parts of silica; 4 parts of alumine combined with oxide of iron; the same quantity of pulverised brick, and two parts of hot lime; the whole measured by weight and not by bulk.

Put the mixture into a large wooden tub, in order that nothing foreign shall be introduced into it. If sufficient water is poured out to extinguish the lime and give a degree of liquidness to the cement, and if all the component parts are briskly stirred, a great degree of heat will be emitted from the lime, and an intimate union formed by the heat.

Roman Cement.—A sort of plaster so called, which well withstands our soft climate, is made by mixing 1 bushel of lime slaked, with 3 pounds and a half of green copperas, 15 gallons of water, and half a bushel of fine gravel sand. The copperas should be dissolved in hot water; it must be stirred with a stick, and kept stirring continually while in use. Care should be taken to mix at once as much as may be requisite for one entire front, as it is very difficult to match the color again; and it ought to be mixed the same day it is used.

(To be continued.)

Fig. 1.



STURGEON'S ELECTRO-MAGNETIC SPHERE, &c.

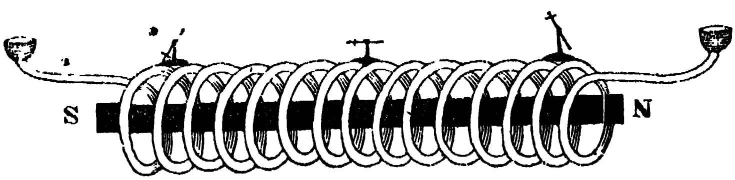


Fig. 2.

STURGEON'S ELECTRO-MAGNETIC SPHERE, &c.

THOSE who would study nature's laws and works must look not only to effects, but to final causes; and we doubt not, that the effects of the magnet, which we last week endeavoured to elucidate, will make our reflective readers desire to learn somewhat of the cause which produces these effects. In this department of science, as in all others, we are enabled to attain to a certain point only, all beyond is still, and perhaps ever will remain, a mystery.

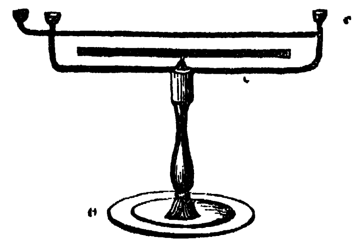
The electric fluid and the magnetic fluid we know only by their effects; but whether they be one and the same, or distinct, we cannot tell, and even the word fluid, when applied to such sciences, is a term assumed to be correct, rather than proved to be so. Such a term, however, is convenient in use, and to consider that there are distinct fluids to produce electrical and magnetic effects, is equally convenient, therefore, we shall continue, as of old, to use the terms in contradiction to each other.

Limited, however, as is our knowledge of the origin of these fluids, this we are certain of—that they mutually influence each other, and that in an extraordinary manner. It is the consideration of these influences which constitutes the science of *electro-magnetism.* A noble field of valuable research in which we shall find analogous effects, proceeding from apparently opposite causes. Electrized wires will be seen to assume the power of magnets, and to exhibit polarity, dip, like attractions and repulsions, and all the other phenomena of magnetism. Magnets will be made and destroyed by electricity; they will be turned from their course, and driven round with power and rapidity, by the approach of electrical agents; and influence in a contrary direction, but in a corresponding manner, the very agents by which they are themselves affected; and finally, we shall have reason to believe, that the magnetism of the earth itself, is but a power created by the mighty power of electricity.

M. Œstead, Professor of Natural Philosophy to the Royal Society at Copenhagen, connected together by a straight thick wire the two poles of a galvanic battery, when it was in action; and holding close above it a suspended magnet, discovered that the needle was deflected out of its course: so much so, indeed, as to stand many degrees from its polar position; and whenever the power was sufficiently strong, to stand nearly at right angles to that direction which was usual to it, pointing nearly east and west, instead of north and south. When the needle was held below the wire, it was equally deflected, but in a contrary direction. These experiments were the first to establish the influence of a current of electricity over the magnet, and to establish the science of electro-magnetism.

To show this experiment satisfactorily, the following apparatus is usually employed :—

It consists of a stand supporting an oblong ring of wire, so constructed that the two wires of which it is composed are soldered together at the end, where the single cup is placed, but separated from each other by a little pad of silk, paper, or wax, or other non-conductor, at the point where the wires cross each other at the opposite end. In this contrivance, while the end with the single cup is kept in connection with one end of the battery, the wire which communicates with the other end, may, with but little trouble, be shifted from one of the remaining cups to the other. If the wires from the battery connect the outside cups, the electric fluid will pass over the magnetic needle, which is suspended in the ring of wire; if the inner cup hold one wire, the fluid passes under the needle, occasioning a contrary deviation; and be it always remembered, as the fundamental law of the science, that " the pole *above* which the *positive* electricity enters, is turned towards the EAST, and that under which it enters to the WEST." Another law offers



itself to our regard by the same experiment, and that is, that the direction of the magnetic force is across that of the electrical; and also, that a stream of the electrical or galvanic fluid, for it is the same, running in one direction, tends to produce a magnetic current at right angles to it; and pursuing the experiment with an apparatus, the wires of which are more or less distant from the magnet, it would be found that the maximum of effect would be when the stream runs as close as possible to the magnet, and diminishes in effect, according to the square of the distance from it. These are all the laws to be borne in mind in our future progress; it is our duty from time to time to prove their truth and application.

The method of making magnets by galvanism was explained and illustrated in Part VIII., pages 305-6 —we stop not, therefore, to repeat the process, though a few words on the cause of needles or bars becoming magnetic by this means deserves an observation or two, more especially as we have not found any explanation elsewhere. Before the influence of electricity upon magnets was known, it required the power of an immense electrical battery to magnetize a common sewing needle—and even then the experiment more frequently failed than succeeded; the best way was found to lay the needle *across* the wire through which the shock passed. This is a curious fact, at that time unaccountable, now easily explained. From the law of the magnetic fluid, and the electrical being tangential to each other; when the shock passed longitudinally through the needle, the only effect it could possibly have, was to arrange the fluid in the needle; so that one *side* of it should have north polarity, the other south—and these poles, therefore, would have been so close to each other, as not to be able to show the effect which might have been produced. When the needle was placed across the current, then the *ends* became polar—still the effect was weak, because the needle touched the wire but in one point; when the wire was twisted round the needle once, it of course touched it all round; and in one part twice; the effect was therefore doubled; many turns, or forming the conducting wire into a coil around it, the effect was proportionably increased; and by this means a small half-pint

Leyden jar will make a more powerful magnetic needle, than the largest battery of former times.

We would refer now to a paper in the same Part of Magazine, before alluded to, page 310, "On the Probable Cause of Planetary Motion." Not with a view of proving, nor yet, perhaps, maintaining, all that is there surmised; but only in reference to the cause of the earth's magnetism, supposed by most philosophers to be the electrical currents flowing around the equatorial regions; and, thereby, occasioning a stream of magnetism from the north and south, of sufficient power to produce those effects we call magnetic.

First, consider the helix No. 2, as having a bar of iron within it, and a stream of electricity passing along the helix—thus making the bar a magnet. It is evident that a dipping needle placed above the coiled wire would be attracted in different parts toward the respective poles of the bar; take the bar away, still the needle will be similarly affected—showing that the coil itself has a power over it, independent of the magnet within-side.

That the hotter regions of the earth have a circulation of the electric fluid around them is proved by numerous appearances, experiments, and arguments, which time will not permit us now to inquire into. That it is this circulation which occasions the magnetic influence is not capable of being proved in a positive manner by direct experiment on the earth itself, yet one thing is certain, that no known fact weakens such a supposition, but every thing learnt respecting this science, confirms it the more strongly. Mr. Sturgeon, to whom electricity owes so much, invented a valuable instrument to show at the same time the polarity and dip of a needle resting on a electro-magnetic globe. It is represented in Fig. 1. It consists of a globe resembling the artificial globe of the earth, around the tropical regions of which a continued coil of wire is wound and connected by its ends with the poles of a small galvanic battery. The globe either contains a bar of iron as is seen in the figure, or what is infinitely better, is made of thin sheet iron, (we believe Mr. Sturgeon used a military shell or hollow cannon ball) the electric fluid passing along the coil, magnetizes the iron and a small magnetic needle placed on any part of the globe has the same polarity and the same dip, as the compass needle is found to have when carried over different parts of the earth's surface.

(To be continued.)

PURIFICATION OF OX-GALL.

Painters in water colors, scourers of clothes, and many others, employ ox-gall or bile, but when it is not purified, it is apt to do harm from the greenness of its own tint. It becomes therefore an important object to clarify it, and to make it limpid and transparent like water. The following process has been given for that purpose. Take the gall of newly killed oxen, and after having allowed it to settle for 12 or 15 hours in a basin, pour the supernatant liquor off the sediment into an evaporating dish of stone ware, and expose it to a boiling heat in a water bath, till it is somewhat thick. Then spread it upon a dish, and place it before a fire till it becomes nearly dry. In this state it may be kept for years in jelly pots covered with paper, without undergoing any alteration. When it is to be used, a piece of it of the size of a pea is to be dissolved in a tablespoonful of water,

Another and probably a better mode of purifying ox-gall is the following. To a pint of the gall boiled and skimmed, add one ounce of fine alum in powder, and leave the mixture on the fire till the alum be dissolved. When cooled, pour it into a bottle, which is to be loosely corked. Now take a like quantity of gall also boiled and skimmed, add an ounce of common salt to it, and dissolve with heat; put it when cold into a bottle, which is likewise to be loosely corked. Either of these preparations may be kept for several years without their emitting a bad smell. After remaining three months, at a moderate temperature, they deposit a thick sediment, and become clearer, and fit for ordinary uses, but not for artists in water colors and miniatures, on account of their yellowish-green color. To obviate this inconvenience, each of the above liquors is to be decanted apart, after they have become perfectly settled, and the clear portion of both mixed together in equal parts. The yellow coloring matter still retained by the mixture coagulates immediately and precipitates, leaving the ox-gall perfectly purified and colorless. If wished to be still finer it may be passed through filtering paper; but it becomes clearer with age, and never acquires a disagreeable smell, nor loses any of its good qualities.

Clarified ox-gall combines readily with coloring matters or pigments, and gives them solidity either by being mixed with or passed over them upon paper. It increases the brilliancy and the durability of ultramarine, carmine, green, and in general of all delicate colors, whilst it contributes to make them spread more evenly upon the paper, ivory, &c. When mixed with gum Arabic, it thickens the colors without communicating to them a disagreeable glistening appearance; it prevents the gum from cracking, and fixes the colors so well that others may be applied over them without degradation. Along with lamp black and gum, it forms a good imitation of China ink. When a coat of ox-gall is put upon drawings made with black lead or crayons, the lines can no longer be effaced, but may be painted over safely with a variety of colors previously mixed up with the same ox-gall.

Miniature painters find a great advantage in employing it; by passing it over ivory, it removes completely the unctuous matter from its surface; and when ground with the colors, it makes them spread with the greatest ease, and renders them fast.

It serves also for transparencies. It is first passed over the varnished or oiled paper, and is allowed to dry. The colors mixed with the gall are then applied, and cannot afterwards be removed by any means.

It is adapted finally for taking out spots of grease and oil.

GENERAL EFFECTS OF HEAT.

Dilatation.—The first and most common effect of heat is to increase the size of the body to which it is imparted. This effect is called dilatation, or expansion; and the body so affected is said to expand or be dilated. If heat be abstracted from a body, the contrary effect is produced, and the body contracts. These effects are produced, in different degrees and estimated by different methods, accord-

ing as the bodies which suffer them are solids, liquids, or airs.

The dilatation of solids is very minute, even by considerable additions of heat; that of liquids is greater, but that of air is greatest of all.

The force with which a solid dilates is equal to that with which it would resist compression; and the force with which it contracts is equal to that with which it would resist extension. Such forces are therefore proportional to the strength of the solid, estimated with reference to the power with which they would resist compression or extension.

The force with which liquids dilate is equivalent to that with which they would resist compression; and, as liquids are nearly incompressible, this force is very considerable.

As air is capable of being compressed with facility, its dilatation by heat is easily resisted. If such dilatation be opposed, by confining air within fixed bounds, then the effect of heat, instead of enlarging its dimensions, will be to increase its pressure on the surface by which it is confined.

Ex. 1.—The works of clocks and watches swell and contract with the vicissitudes of heat and cold to which they are exposed. When the pendulum of a clock, or a balance wheel of a watch, is thus enlarged by heat, its wings more slowly, and the *rate* is diminished. On the other hand, when it contracts by cold, its vibration is accelerated, and the rate is increased. Various contrivances have been resorted to, to counteract these effects.

Ex. 2.—When boiling water is poured into a thick glass, the unequal expansion of the glass will tear one part from another, and produce fracture.

Ex. 3.—The same vessel contains a greater quantity of cold than of hot water.

If a kettle, completely filled with cold water, be placed on a fire, the water, when it begins to get warm, will swell, and spontaneously flow from the spout of the kettle, until it ceases to expand.

Ex. 4.—If a bottle, well corked, be placed before the fire, especially if it contain fermented liquor in which air is fixed, the air confined in it will acquire increased pressure by the heat imparted to it, and its effort to expand will at length be so great that the cork will shoot from the bottle, or the bottle itself will burst.

Thus we perceive that the magnitude of body depends on the quantity of heat which has been imparted to it, or abstracted from it; and as it must be in a state of continual variation with respect to its magnitude, we can, therefore, never pronounce on the magnitude of any body with exactness, unless we are at the same time informed of its situation with respect to heat. Every hour the bodies around us are swelling and contracting, and never for one moment retain the same dimensions; neither are these effects confined to their exterior dimensions, but extend to their most intimate component particles. These are in a constant state of motion, alternately approaching to and receding from one another, and changing their relative positions and distances. Thus, the particles of matter, sluggish and inert as they appear, are in a state of constant motion and apparent activity.

Liquefaction.—Let a mass of snow, at the temperature of 0°, having a thermometer immersed in it, be exposed to an atmosphere of the temperature of 60°. As the snow gradually receives heat from the surrounding air, the thermometer immersed in it will be observed to rise until it attain the temperature of 32°. The snow will then immediately begin to be converted into water, and the thermometer will become stationary. During the process of liquefaction, and while the snow constantly receives heat from the surrounding air, the thermometer will still be fixed, nor will it begin to rise until the process of liquefaction is completed. Then, however, the thermometer will again begin to rise, and will continue to rise until it attain the same temperature as the surrounding air.

Heat, therefore, when supplied to the snow in a sufficient quantity, has the effect of causing it to pass from the solid to the liquid state, and while so employed becomes incapable of affecting the thermometer. The heat thus consumed or absorbed in the process of liquefaction is said to become latent; the meaning of which is, that it is in a state incapable of affecting the thermometer.

The property here described, with respect to snow, is common to all solids. Every body in the solid state, if heat be imparted to it, will at length attain a temperature at which it will pass into the liquid state. This temperature is called its *point of fusion*, its *melting point*, or its *fusing point;* and in passing into the liquid state, the thermometer will be maintained at the fixed temperature of fusion, and will not be affected by that heat which the body receives while undergoing the transition from the solid to the liquid state.

Ebullition.—If water at the temperature of 60° be placed in a vessel on a fire having a thermometer immersed in it, the thermometer will be observed gradually to rise, and the water will become hotter, until the thermometer arrives at the temperature of 212°. Having attained that point, the water will be observed to be put into a state of agitation, and bubbles of steam will constantly rise from the bottom of the vessel, and escape, at its surface, the thermometer still remaining stationary at 212°. This process is called ebullition, and the water is said *to boil;* but no continued supply of heat nor any increased intensity in the fire, can communicate to the water a higher temperature than 212°.

Other liquids are found to undergo a like effect. If exposed to heat, their temperatures will constantly rise, until they attain a certain limit, which is different in different liquids; but having attained this limit, they will enter into a state of ebullition, and no addition of heat can impart to them a higher temperature. The temperature at which different liquids thus boil is called their *boiling points.*

The meltirg or freezing points, and the boiling points, constitute important physical characters, by which different substances are distinguished from each other.

When heat continues to be supplied to a liquid which is in the state of ebullition, the liquid is gradually converted into vapour or steam, which is a form of body possessing the same physical characters as atmospheric air. The steam or vapour thus produced has the same temperature as the water from which it was raised, notwithstanding the great quantity of heat imparted to the water in its transition from the one state to the other. This quantity of heat is therefore *latent.*

Solidification or Congelation.—The abstraction of heat produces a series of effects contrary to those just described. If heat be withdrawn from a liquid, its temperature will first be gradually lowered until it attain a certain point, at which it will pass into the solid state. This point is the same as that at which, being solid, it would pass into the liquid state. Thus, water gradually cooled from 60° down-

wards will fall in its temperature until it attains the limit of 32°: there it passes into the solid state, and forms ice; and during this transition a large quantity of heat is dismissed, while the temperature is maintained at 32°.

Condensation.—In like manner, if heat be withdrawn from steam or vapour, it no longer remains in the aëriform state, but resumes the liquid form. In this case it undergoes a very great diminution of bulk, a large volume of steam forming only a few drops of liquid. Hence the process by which vapour passes from the aëriform to the liquid state has been called condensation.

Vaporisation.—When a liquid boils, vapour is generated in every part of its dimensions, and more abundantly in those parts which are nearest the source of heat, but liquids generate vapour *from their surfaces* at all temperatures. Thus, a vessel of water at the temperature of 80° will dismiss from its surface a quantity of vapour; and if its temperature be retained at 80°, it will continue to dismiss vapour from its surface at the same rate, until all the water in the vessel has disappeared.• This process, by which vapour is produced at the surface of liquids, at temperatures below their boiling point, is called vaporisation.

Evaporation.—The process of vaporisation is generally going on at the surface of all collections of water, great or small, on every part of the globe, but it is in still more powerful operation when liquid juices are distributed through the pores, fibres, and interstices of animal and vegetable structures. In all these cases, the rate at which the liquid is converted into vapour is greatly modified by the pressure of the atmosphere. The pressure of that fluid retards vaporisation, if its effects be compared with that which would take place in a vacuum; but, on the other hand, the currents of air continually carrying away the vapour as fast as it is formed, in the space above the surface, gives room for the formation of fresh vapour, and accelerates the transition of the liquids to the vaporous state. The process of vaporisation, thus modified by the atmosphere and its currents, so far as it affects the collections of water and liquids generally in various parts of the earth, is denominated evaporation.

The condensation of the vapour, thus drawn up and suspended in the atmosphere by various causes, tending to extricate the latent heat which gives to it the form of air, produces all the phenomena of dew, rain, hail, snow, &c. &c. A slight degree of cold converts the vapour suspended in the atmosphere into a liquid; and by the natural cohesion of its molecules, it collects into spherules or drops, and falls in the form of rain. A greater degree of cold solidifies or congeals its minute particles, and they descend to the earth in flakes of snow. If, however, they are first formed into liquid spherules, and then solidified, hail is produced.

Thus there is a constant interchange of matter between the earth and its atmosphere,—the atmosphere continually drawing up water in the form of vapour, and, when the heat which accomplishes this is diminished, precipitating it in the form of dew, rain, snow, or hail.

(To be continued.)

USE OF SAND FOR CUTTINGS OF TREES, SHRUBS, &c.

The finest white sand is superlatively useful to autumn-planted cuttings of the more tender evergreen trees and shrubs. In the business of planting cuttings of these under hand-glasses, in the autumn, as well as the more hardy green-house plants, such as myrtles, fuschia, roses, cistuses, germander, &c., no unmixed soil whatever can be found to bear a comparison with the finest white sand; as cuttings planted therein will be far more secure from mouldiness throughout the autumnal and winter seasons; during which times, the pots in which they are planted, generally remain standing up to their rims in the common ground, as the greatest preservative from frost; but in which situation, they are more exposed to the ill effects of damp, than if standing on the surface.

Although but little more than a knot, or a swelling protuberance, at the foot of each cutting, can be effected, during the first autumn; yet, on the advance of spring, they will early make roots, even without the addition of any other soil or article to promote their growth; and which young plants, being potted off, or transplanted in some way, as soon as they have formed sufficient roots; immense quantities, from these small cuttings, may thus be annually propagated, by the help of full-sized single hand-glasses This process, however, will not extend to any other description of plants than the evergreens.

In the propagation of the trees and shrubs alluded to by this process, it must be recollected, that the sand is to be considered as no farther essential, than to strike or promote growth in the cuttings, sufficient for transplantation; as, on their being removed into another situation, in the next stage of the process, a mixture of suitable soil, with a proportion of sand only, will be requisite.

We are not asserting that yellow-sand will not equally apply in both cases, of planting cutting of hardy evergreen trees and shrubs, both by summer-planting, in the open exposure, and autumn planting, under hand-glasses; but in all the experiments we have witnessed, white-sand, where it could be obtained, has been invariably applied, and most successfully.

When we reflect, that mouldiness is the chief annoyance to cuttings of almost every description, when planted under hand-glasses; every propagator should strenuously guard against it: and we know of nothing so likely to discharge wet, and prevent undue retention of moisture, as sand alone; and this, in preference to every other soil and compost.

There are few soils with which sand cannot be intermingled to the greatest advantage in various other branches of horticulture, as well as in the propagation of plants and flowers; it being admirably adapted, from its loose and open nature, to expand the pores of heavier, more close, and adhesive soils, thereby opening the entire mass of compost, and rendering it porous, and open to the free admission, and full expansion of the delicately fine, and thread-like roots of plants and flowers, and in which we have most satisfactorily witnessed its singular and superior efficacy. We have known in various cases, plants to have been placed in soils most opposite and ungenial to their natures and constitutions, and thereby early inclining to decay; but which were speedily restored to their original vigour and complexion, by a proper and timely application of white-sand.

The sand which has invariably been found to surpass all others for general and special purposes in horticulture, is a peculiarly soft and fine white

sand, of an unusual smoothness, nearly as fine as flour-emery.

Where none other than the common white sand, which is usually coarse, can be obtained, small quantities of the most fine can be sifted out with a fine sieve; or still better procured from it by washing over.

Little argument can be necessary to convince the unprejudiced florist, gardener, or amateur, of the general utility of suitable sands being mixed with the more cold and heavier soils; thereby rendering them open and porous to discharge all copious falls of rain, dissolving snow, &c.; and which tend to overcharge adhesive soils with an undue proportion of moisture, and thereby to chill and starve the stock of plants and flowers.

FUEL.

SUCH combustibles as are used for fires or furnaces are called fuel, as wood, turf, pit-coal. These differ in their nature, and in their power of giving heat.

1. Wood, which is divided into hard and soft. To the former belong the oak, the beech, the ash, the birch, and the elm; to the latter, the fir, the pine of different sorts, the larch, the linden, the willow, and the poplar.

Under like dryness and weight, different woods are found to afford equal degrees of heat in combustion. Moisture diminishes the heating power in three ways; by diminishing the relative weight of the ligneous matter, by wasting heat in its evaporation, and by causing slow and imperfect combustion. If a piece of wood contain, for example, 25 per cent. of water, then it contains only 75 per cent. of fuel, and the evaporation of that water will require one twenty-eighth part of the weight of the wood. Hence the damp wood is of less value in combustion by twenty-eight parts in 100 or two-sevenths than the dry. The quantity of moisture in newly-felled wood amounts to from 20 to 50 per cent.; birch contains 30, oak 35, beech and pine 39, alder 41, fir 45. According to their different natures, woods which have been felled and cleft for 12 months contain still from 20 to 25 per cent. of water. There is never less than 10 per cent. present, even when it has been kept long in a dry place, and though it be dried in a strong heat, it will afterwards absorb 10 or 12 per cent. of water. If it be too strongly kiln dried, its heating powers are impaired by the commencement of carbonization, as if some of its hydrogen were destroyed. It may be assumed as a mean of many experimental results, that one pound of artificially dried wood will heat 35 pounds of water from the freezing to the boiling point; and that a pound of such wood as contains from 20 to 25 per cent. of water will heat 26 pounds of ice-cold water to the same degree. It is better to buy wood by measure than by weight, as the bulk is very little increased by moisture. The value of different woods for fuel is inversely as their moisture, and this may easily be ascertained by taking their shavings, drying them in a heat of 140° F., and seeing how much weight they lose.

From every combustible the heat is diffused either by radiation or by direct communication to bodies in contact with the flame. In a wood fire the quantity of radiating heat is to that diffused by the air, as 1 to 3; or it is one-fourth of the whole heating power.

2. *Charcoal.* The different charcoals afford, under equal weights, equal quantities of heat. We may reckon, upon an average, that a pound of dry charcoal is capable of heating 73 pounds of water from the freezing to the boiling point; but when it has been for some time exposed to the air, it contains at least 10 per cent. of water, which is partially decomposed in the combustion into carburetted hydrogen, which causes flame, whereas pure dry charcoal emits none.

A cubic foot of charcoal from soft wood weighs upon an average from 8 to 9 pounds, and from hard wood 12 to 13 pounds; and hence the latter are best adapted to maintain a high heat in a small compass. The radiating heat from charcoal fires constitutes one-third of the whole emitted.

3. *Pit-coal.* The varieties of this coal are almost indefinite, and give out very various quantities of heat in their combustion. The carbon is the heat-giving constituent, and it amounts, in different coals, to from 75 to 95 per cent. One pound of good pitcoal will, upon an average, heat 60 pounds of water from the freezing to the boiling point. Small coal gives out three-fourths of the heat of the larger lumps. The radiating heat emitted by burning pit-coal is greater than that by charcoal.

4. *The Coke of Pit-coal.*—The heating power of good coke is to that of pit-coal as 75 to 69. One pound of the former will heat 65 pounds of water from 31° to 212°; so that its power is equal to nine-tenths of that of wood charcoal.

5. *Turf or Peat.*—One pound of this fuel will heat from 25 to 30 pounds of water from freezing to boiling. Its value depends upon its compactness and freedom from earthy particles; and its radiating power is to the whole heat emits in burning, as 1 to 3.

6. *Carburetted Hydrogen or Coal Gas.*—One pound of this gas, equal to about 24 cubic feet, disengages in burning, as much heat as will raise 76 pounds of water from the freezing to the boiling temperature.

It appears that in practice, the quantity of heat which may be obtained from any combustible in a properly mounted apparatus, must vary with the nature of the object to be heated. In heating chambers by stoves, and water boilers by furnaces, the effluent heat in the chimney which constitutes the principal waste, may be reduced to a very moderate quantity, in comparison of that which escapes from the best constructed reverberatory hearth. In heating the boilers of steam engines, one pound of coal is reckoned to convert 7½ pounds of boiling water into vapour; or to heat 41¼ pounds of water from the freezing to the boiling point. One pound of fir of the usual dryness will evaporate 4 pounds of water, or heat 22 pounds to the boiling temperature; which is about two-thirds of the maximum effect of this combustible. According to Watt's experiments upon the great scale, one pound of coal can boil off with the best built boiler, 9 pounds of water; the deficiency from maximum effect being here ten fifty-sevenths, or nearly one-sixth.

In many cases the hot air which passes into the flues or chimneys may be beneficially applied to the heating, drying, or roasting of objects; but care ought to be taken that the draught of the fire be not thereby impaired, and an imperfect combustion of the fuel produced. For at a low smothering temperature both carbonic oxide and carburetted hydrogen may be generated from coal, without the production of much heat in the fire-place.

BUILDING CEMENTS.

(Resumed from page 296, and concluded.)

To make Parker's Cement.—This cement is made of very argillaceous limestones, which are burnt in conical kilns, with a continued fire of pit-coal, in the same manner as other limestones; but if the heat be so great as to cause a commencement of fusion in the cement, it will be totally spoiled. It is reduced to an impalpable powder by grinding as soon as it is burnt, and is sent away in barrels well closed.

The above is much used in London for facing houses, and for the foundations of large edifices. It requires much practice in the workmen who use it: for if not tempered to the proper consistence, and immediately applied, it solidifies unequally, cracks, and adheres badly. It is recommended to be mixed with fine angular sand well washed, in the proportion of 2 parts to 3 of cement, for foundations and cornices exposed to rain; from 3, 4, and 5 parts to 3 of cement for common mortars: from 3 parts to 2 of cement for coating walls exposed to cold, and 5 parts to 2 of cement for walls exposed to dryness or heat.

Cement for Rock-work and Reservoirs.—Where a great quantity of cement is wanted for coarser uses, the coal-ash mortar (or Welsh tarras) is the cheapest and best, and will hold extremely well, not only where it is constantly kept wet or dry, but even where it is sometimes dry and at others wet; but where it is liable to be exposed to wet and frost, this cement should, at its being laid on, be suffered to dry thoroughly before any moisture has access to it; and, in that case, it will likewise be a great improvement to temper it with the blood of any beast.

The mortar must be formed of 1 part lime and 2 parts of well-sifted coal ashes, and they must be thoroughly mixed by being beaten together; for on the perfect commixture of the ingredients the goodness of the composition depends.

Tunisian Cement.—This is composed of 3 parts of lime, 1 of sand, and 2 of wood ashes; these ingredients are mixed up with oil, and water alternately till they compose a paste of the desired consistency.

Dutch Terras.—This is composed of basalt ground to a fine powder, and blue argillaceous lime, mixed up with water, and well beaten together.

Tournay Cement.—Is a mixture of coal ashes, with blue argilloferruginous lime and sand, well beaten up with water, left to dry, repeatedly levigated, moistened, and beaten.

Genuine Roman Cement.—This consists of the *pulvis Puteolanus*, or *Puzzolene*, a ferruginous clay from Puteoli, calcined by the fires of Vesuvius, lime and sand, mixed up with soft water. The only preparation which the Puzzolene undergoes is that of pounding and sifting; but the ingredients are occasionally mixed up with bullock's blood, and fat of animals, to give the composition more tenacity.

Maltha, or Greek Mastich.—This is a more simple composition than the cement of the Romans, when used for stucco on the outsides of fabrics, consisting only of lime and sand, but rendered into a paste with milk, or *size*.

Indian Cement.—This is only a variation of the mastich, and is composed of equal quantities of flint, lime, and pit-sand, slaked with water, well beaten, and suffered to remain for three or four days, then moistened and mixed up with oil, mucilage, whites of eggs, and butter-milk, and applied, as rapidly as possible, after being mixed.

To make impenetrable Mortar.—Mix thoroughly one-fourth of the fresh unslaked lime with three-fourths of sand; and let five labourers make mortar of these ingredients by pouring on water, with trowels to supply one mason, who must when the materials are sufficiently mixed, apply it instantly as cement or plaster, and it will become as hard as stone. The lime used should be stone-lime; previous to its use, it should be preserved from the access of air or wet, and the plaster screened for some time from the sun and wind.

To make Wych's Stucco.—Take 4 or 5 bushels of such plaster as is commonly burnt for floors about Nottingham (or a similar quantity of any tarras, plaster, or calcined gypsum); beat it to fine powder, then sift and put it into a trough, and mix with it 1 bushel of pure coal ashes well calcined. Pour on the water, till the whole becomes good mortar. Lay this in wooden frames of twelve feet in length on the walls, well smoothed with common mortar and dry, the thickness of two inches at each side, and three inches in the middle. When the frame is moved to proceed with the work, leave an interval of two inches for this coping to extend itself, so as to meet the last frame work.

To make Williams's Stucco.—Take sharp, rough, large-grained sand, sifted, washed, dried, and freed from all impurities, 84 pounds: well burnt lime, slaked and finely sifted, 12 pounds; curd, or cheese, produced from milk, 4 pounds; (the first, fresh made, and strongly pressed, to divest it of its whey; the second, whilst perfectly sound, rasped into powder with a grater, or brought into very light substance with scrapers, or fine-toothed plane-irons, in a turner's lathe;) and lastly, water in its natural state 10 pounds. If the sand is not thoroughly dried, or the lime has got damp from the air, the quantity of water must be less than the above proportion; and on the contrary, when the lime is used immediately, it may require more; so that the proper stiffness of the mortar, under those circumstances, will regulate the making of the composition.

Water Cement.—A cement may be made with common lime that will harden *under water*. What is called *poor* lime has this peculiar property; but as this species of limestone rarely occurs, it is often an expensive article. The following is a good substitute, and may be used for water cisterns, aqueducts, &c.—Mix 4 parts of grey clay, 6 of the black oxide of manganese, and 90 of good limestones reduced to fine powder; then calcine the whole to expel the carbonic acid. When this mixture has been well calcined and cooled, it is to be worked into the consistence of a soft paste with 60 parts of washed sand. If a lump of this cement be thrown into water it will harden immediately. Such mortar, however, may be procured at a still less expense, by mixing with common quicklime a certain quantity of what are called the *white* iron ores, especially such as are poor in iron. These ores are chiefly composed of manganese and carbonate of lime or chalk. Common lime and sand only, whatever may be the proportion of the mixture, will certainly become soft under water.

Water Cement or Stucco.—Take 56 pounds of pure coarse sand, 42 pounds of pure fine sand; mix them together, and moisten them thoroughly with lime water: to the wetted sand, add 14 pounds of pure fresh burnt lime, and while beating them up together, add, in successive portions, 14 pounds of bone ash: the quicker and more perfectly these materials are beaten together, and the sooner they

are used, the better will be the cement; for some kinds of work it will be better to use fine sand alone, and for others, coarse sand; remembering the finer the sand is, the greater quantity of lime is to be employed.

GRADUATION OF HYDROMETERS.

Cut a band of paper on which the graduation of the instrument can be traced, and let fall upon it a little drop of sealing-wax; then roll the paper upon a little glass tube, and introduce it into the stalk of the hydrometer. The instrument is afterwards to be plunged into distilled water, which is carefully kept at the temperature of 40° F. above zero. Give the instrument sufficient ballast to make it sink till the point which you desire to make to represent the density of water, touches the surface of the water. Mark this point with much precision; it is the zero of the instrument. The other degrees are taken by plunging the hydrometer into distilled water to which you have added 1, 2, 3, 4, 5, &c., *tenths*, or 1, 2, 3, 4, 5, &c. *hundredths*, of the substance for which you wish to construct the hydrometer, according as you desire the scale to indicate tenths or hundredths.

When you have thus marked the degrees in the stalk of the instrument, transfer them to the paper with the help of the compasses. The scale being completed, replace it in the tube of the hydrometer, where it must be fixed; in so doing, take care to make the degrees on the scale coincide precisely with those marked on the stalk.

You can thus procure hydrometers for alcohol, acid, salts, &c. which are instruments that indicate the *proportion* of alcohol, acid, salt, &c., contained in a given mass of water.

But if it were necessary to plunge the hydrometer in a hundred different solutions in order to produce the scale, it is easy to conceive that that would be extremely troublesome, especially for hydrometers which are employed in commerce, and which do not need to be so extremely accurate. When the density of the mixtures or solutions is a mean between those of the substances which enter into them, you may content yourself with marking the zero and one other fixed point. Then, as the stalk of the hydrometer is evidently of equal diameter in all its extent, you can divide the space which separates the two fixed points into a certain number of equal parts. One of these, being taken for unity represents a particular quantity of the substance which you have added to a determined weight of distilled water. By means of this unity you can carry the scale up and down the stalk of the instrument. It is thus, that to obtain a Baume's hydrometer, after having obtained the zero by immersion in distilled water, you plunge the instrument into a solution containing a hundred parts of water and fifteen of common salt, to have the 15th degree, or containing a hundred water and thirty salt, to have the 30th degree. Upon dividing the interval in fifteen or thirty equal parts, according as you have employed one or other solution, you obtain the value of the degree, which you can carry upwards or downwards as far as you wish.

Among the substances for which hydrometers are required in commerce, are some which it is impossible to obtain free from water—such are alcohol, the acid, &c. In this case it is necessary to employ the substances in their purest state, and deprived of as much water as possible.

The employment of hydrometers is very extensive; they are used to estimate the strength of leys, of soap solutions, of wines, milk, &c. There is, in short, no branch of commerce in which these instruments are not required for the purpose of ascertaining the goodness of the articles which are bought and sold. The employment of hydrometers would be still more general, if they could be made to give immediately the absolute specific gravity of the liquids into which they might be plunged, the specific gravity of water being considered as unity. It is possible to graduate a thermometer of this description by proceeding as follows;—

Make choice of a hydrometer of which the exterior part of the stalk is very regular. Introduce the band of paper on which the scale is to be written, and then ballast the instrument. Make a mark where the surface of the distilled water touches the stalk. Remove the hydrometer from the water, wipe it perfectly dry, and weigh it very accurately with a sensible balance. Then pour into it a quantity of mercury equal to its own weight; plunge it again into the water, and again mark the point where the stalk touches the surface of the water. Pour the mercury out of the instrument, transfer the two marks to the scale, and divide this fixed distance into fifty equal parts. Having by this operation obtained the value of the degree, you carry it upwards and downwards, to augment the scale. If you take the first point near the reservoir, the hydrometer will be proper to indicate the density of liquids which are heavier than water; if you take it towards the middle of the tube, the contrary will be the case.

If you destine the hydrometer liquids much heavier than water—such as acids, for example—you might, after having determined the first point, add to the original ballast as much mercury as is equal to the weight of the whole instrument; then the point where the stalk would touch the surface of the water, and which would be represented by 100, would be very high, and the second point, which would be found below, would be represented by 200. On dividing the space into a hundred equal parts, you would have the value of the degree, which could be carried up and down for the extension of the scale.

The specific gravities being in the inverse ratio of the volumes plunged into the liquid, the number of the scale which mark the specific gravities diminish from below; so that, on marking the lowest point 100, you have on proceeding upwards, the successive degrees.

The hydrometers with two, three, and four branches, are graduated by having their tubes divided into a hundred or a thousand equal parts. The divisions on each branch must correspond with those on the other branches.

New Metal Button.—A button, to be fixed without sewing, has been contrived by Messrs. Rowley and Smeeton, of Birmingham, which, when put on any garment, cannot be taken off by any ordinary force or wear. The shank of this button is made hollow, so that it can be readily rivetted, as it were, on to a stud on the other side of the cloth. It has the advantage of being fixed with great rapidity. The inventors say that the usual time required is only two seconds.

Fig. 1.

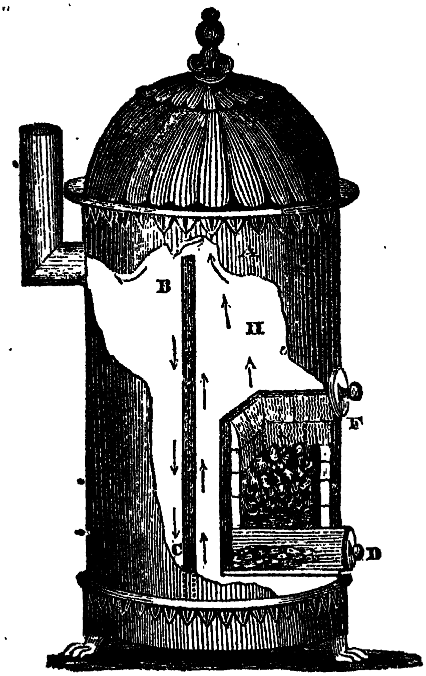
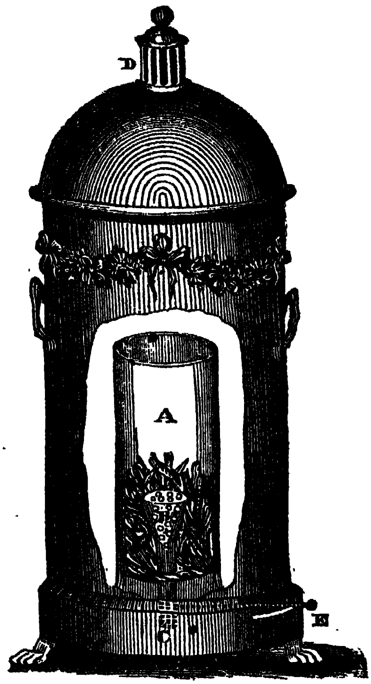
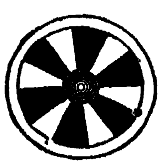
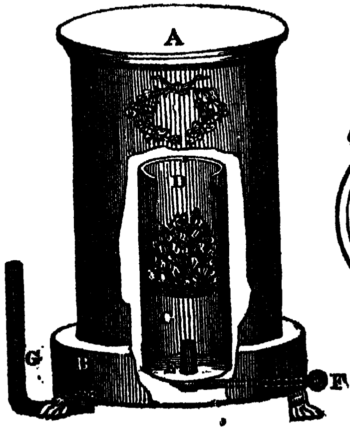


Fig. 2.



ARNOTT'S, JOYCE'S, AND THE CHUNK STOVES.





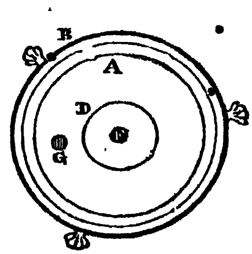


Fig. 5. *Fig.* 3. *Fig.* 4.

ARNOTT'S, JOYCE'S, AND THE CHUNK STOVES.

In this inclement season, a few words on Stoves may not be uninteresting, especially if directed to some of those which are well known by name, yet very little in properties or construction. Perhaps those most patronized are Arnott's, Joyce's, and the Chunk Stove; to these, therefore, we shall chiefly direct our attention at the present time.

Stoves are of four kinds; 1st, open fire-places, or those which communicate heat to the room by the direct radiation of the burning material; 2nd, those that while the fire is kept from view, suffer the air from the fire to escape into the apartment, such as *Joyce's* stove. 3rd, those which contain an inclosed fire, and are furnished with an exterior casing; open at top and bottom, between the fire-box and casing; which, when the fire is lighted, occasions a draught of air upwards; this is the structure of the usual *Hot Air Stoves*. (See page 308.) The 4th kind is an inclosed fire, which, making the surface of a case which contains it hot; by radiation the air around it becomes hot also; of this description is the stove of *Arnott* and the *Chunk* stove.

Arnott's stove, (Fig. 1,) A is the outer case, it may be square, round, or of any other form; B C is a partition that reaches quite across the case A, from one side to the other, but open at the top and bottom; D is the ash-box, having a valve in front to regulate a supply of air to the fire; above the ash-box is seen the fire-place, which is open at top, has the usual bars at bottom, but is inclosed on all the four sides, except a door F, into which the fuel is put when required. The fire-place is lined on its four sides with fire-bricks, which the doctor (Arnott) says, being bad conductors, confine the heat, but which we can, in their present situation, see no use for. When the fire is to be lighted, the regulator at D is to be opened to its fullest extent, and also the door at F; thus a considerable draught of air will rush through the fire, and easily kindle the fuel: when well kindled, F is to be closed and D nearly closed; the supply of air is now very small, and yet enough to promote a slow combustion of the fuel. The air thus admitted, not merely sustains the fire, but passing through it, ascends to the top of the case, and heats the front chamber, as far as the partition B C; the back chamber is yet cold; therefore, the air within it is attracted at the lower opening of it towards the front chamber, the air of the front chamber having been carried upwards by the heat rarifying it; at the same time, the hot air at the top passing through the upper orifice, is there partly condensed, by coming in contact with the sides of the back chamber, and this condensation increasing its gravity it descends. Thus a current of air is always circulating around the partition, as represented by the arrows, although an extremely small quantity is admitted by the orifice D. This current also prevents very much of the heated air from passing away by the chimney.

The chief merit of Arnott's stove is the very small quantity of fuel consumed, and the little attention it requires; yet it is not without its inconveniences, and one of them, may be considered serious, that is, its danger of explosion. It will be evident, that the whole mass of air within the stove will be intermixed with whatever gases and smoke the fuel gives off in burning: also, it will be apparent, that the fire, having no direct draught of air in contact with it, will not burn off the gaseous emanations as they arise, any more than the heat does in the burning of charcoal, or the making of coal gas; if, therefore, the fire be supplied with common coals, or even if too much wood be used in lighting the fire, carburetted hydrogen will escape, and partly occupy the chamber. Should this be the case, it only requires the fire door F to be opened, when a current of air is immediately drawn in, an explosive mixture formed, and the whole ignited. The fuel, therefore, it is of the utmost consequence to regard; that alone being proper and safe which has already been deprived of its gaseous constituents — such as cinders, coke or charcoal.

The Chunk stove (Fig. 3,) is upon the same general construction as the Arnott stove; it differs, however, from it in two important particulars—as will be indicated by the description. A is a hollow thin iron case, capable of being lifted off and on; it rests upon about an inch in depth of dry sand, strewed upon a flat bottom piece B, which bottom is represented in section, in Fig. 4. This has a rim to it about 2 inches in height, also a hole in the centre, to which the pipe E, Fig. 3, is fitted tightly, and another hole at G, upon which the tube for the chimney is fixed—this hole as well as that at the centre, has a rim to it standing above the general surface; so that when sand is strewed on B it shall fill the whole space, yet not be allowed to impede the action of the air regulator at E—nor yet get into the pipe G. Withinside the case A is a small fire-place formed of thin iron, of the shape represented, open at the top, and with a perforated bottom. It fits on and off the short tube, or rather fits into a rim in B, represented as D in Fig. 4.

To light the fire, take off the cover A, and open the register by the handle F; put into D a shovel-full of lighted cinders, and over them a quantity of other cinders until D is filled. When the fire is lighted, partly close the register connected with F; and put over the whole, the cover A. Thus managed the fire will require no attendance during the day. The action of it is easily understood—air being admitted through E supports the combustion, and passing through the fire fills the whole cavity of the vessel A; while its escape is prevented by A dipping into sand—if A should be overcharged with air and smoke, the superabundance will pass away by the pipe G—which may be of any kind of metal, as no possible danger of flame can be apprehended. It will be evident that there is the same danger of explosion here, as in the case of Dr. Arnott's stove; therefore attention to fuel is requisite.

Joyce and Harper's Stove is constructed upon a different principle altogether. Here the air itself which passes from the fire, together with all the smoke and fumes arising with it, escaping into the apartment. (Fig.2) A is a cylindrical fire-place, made of sheet iron. This may be entirely left out; the outer case, which is also of sheet iron answering every purpose, but it is put for the sake of safety, for if there were but one case to contain the fire, it is evident that it would often become red hot, to the danger of the articles around. B is a perforated iron conical tube penetrating into the fire, and admitting air to it by a register at C, which is moved by the handle E. The cover lifts off for the admission of fuel. The fire being lighted and the cover put on, the quantity of air to be admitted is regulated by E. It is decomposed by the burning

fuel, and escapes along with the fumes of that through the apertures at D into the apartment. If the remarks we have before made as to fuels for stoves be well placed there, they are doubly necessary to be observed here; not that there is any danger of explosion, for there is no accumulation takes place, but as every emanation from the fire escapes into the apartment, we must be especially careful not to burn what produces noxious effluvia; and the impossibility of finding any other, renders Joyce's stove useless for general purposes. Coke and cinders there is not a sufficiency of draught to burn; coals and wood yield smoke, which is evidently not to be tolerated in apartments; and charcoal produces carbonic acid gas, one of the most deleterious gases, and one of the most invidious in its action upon the animal economy; this is the material however employed; and these stoves may therefore very truly be designated *choking* stoves, suffocating apparatus, &c. It is said that the charcoal is prepared in such a way that the carbonic acid gas is absorbed by the added material as soon as formed; but the chemist knows that there is no such material can be used, which at the same time admit the charcoal to retain its combustibility and appearance. Fig. 5 shows a section of the register for the admission of air to each stove, it consists of two plates of brass, sliding centrically over each other.

ON THE COLORS OF NATURAL BODIES.

(*Resumed from page* 288, *and concluded.*)

In all *colored solids* and *fluids* in which the transmitted light has a specific color, the particles of the body have absorbed all the rays which constitute the complementary color, detaining sometimes *all* the rays of a certain definite refrangibility, a portion of the rays of other refrangibilities, and allowing other rays to escape entirely free from absorption; all the rays thus stopped will form by their union a particular compound color, which will be exactly complementary to the color of the transmitted rays.

In *black* bodies, such as *coal*, &c., all the rays which enter their substance are absorbed; and hence we see the reason why such bodies are more easily heated and inflamed by the action of the luminous rays. The influence exercised by heat and cooling upon the absorptive power of bodies furnishes an additional support to the preceding views.

Before concluding this chapter, we may mention a few curious facts relative to white opacity, black opacity, and color, as exhibited by some peculiar substances.

1st, Tabasheer, whose refractive power is 1.111, between air and water, is a silicious concretion found in the joints of the bamboo. The finest varieties reflect a delicate azure color, and transmit a straw-yellow tint, which is complementary to the azure. When it is slightly wetted with a wet needle or pin, the *wet spot instantly becomes milk white* and *opaque*. The application of a greater quantity of water restores its transparency.

2dly, The *cameleon mineral* is a solid substance made by heating the pure oxide of manganese with potash. When it is dissolved in a little warm water, the solution changes from *green* to *blue* and *purple*, the last descending in the order of the rings, as if the particles became smaller.

3dly, A mixture of oil of sweet almonds with soap and sulphuric acid is, according to M. Claubry, first *yellow* then *orange*, *red*, and *violet*. In passing from the *orange*, to the *red*, the mixture appears almost *black*.

4thly, If, in place of oil of almonds, in the preceding experiment, we employ oil obtained from alcohol heated with chlorine, the colors of the mixture will be *pale yellow*, *orange*, *black*, *red*, *violet*, and beautiful *blue*.

5thly, *Tincture of turnsole*, after having been a considerable time shut up in a bottle, has an *orange* color; but when the bottle is opened and the fluid shaken, it becomes in a few minutes *red*, and then *violet-blue*.

6thly, A solution of *hæmatine* in water containing some drops of acetic acid is a *greenish yellow*. When introduced into a tube containing mercury, and heated by surrounding it with a hot iron, it assumes the various colors of *yellow*, *orange*, *red*, and *purple*, and returns gradually to its primitive tint.

7thly, Several of the metallic oxides exhibit a temporary change of color by heat, and resume their original color by cooling. M. Chevreul observed, that when indigo, spread upon paper, is volatilised, its color passes into a very brilliant poppy-red. The yellow phosphate of lead grows green when hot.

8thly, One of the most remarkable facts, however, is that discovered by M. Thenard. He found that phosphorus, purified by repeated distillations, though naturally of a whitish yellow color when allowed to cool slowly, *became absolutely black* when thrown melted into cold water. Upon touching some little globules that still remained yellow and liquid when he was repeating this experiment, M. Biot found that they instantly became solid and black.

DICTIONARY OF ARTS AND SCIENCES.*

The Editor and Proprietor of this Magazine have undertaken the above work, to supply what they consider has been long and much wanted by the artizan, student, and general reader, namely, a cheap work of reference, explanatory of the terms, apparatus, instruments, materials and processes employed in all the Mechanical Arts and Experimental Sciences. The present Dictionary includes Architecture, Civil Engineering, Practical Mechanics, Chemistry, Manufacturing Processes, the Mathematics, Fine Arts, and the whole range of Natural Philosophy; each word and instrument is explained in easy language, and when necessary illustrated by a wood-cut. It would ill become the Editor to eulogise his own production, but he trusts that he may be allowed to give a sample of the work, more especially as it will afford him an opportunity of describing some instruments which have not appeared in the Magazine. To do this fairly, he will take a word or two on each important subject:—

"Absolute Number. In algebra that term in an equation which is completely known, and which is equal to all the other terms taken together. In the equation $x+5\ \ y\times 2=30$. The 30 is the absolute number.

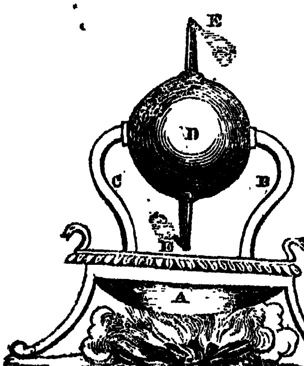
* This work is now publishing in Weekly Numbers at 1½d. and Monthly Parts at 7d.; each part containing about 60 well executed wood cuts. The whole printed in the best manner, and will be completed in 10, or at most 12 Monthly Parts.

"Acanthus. In architecture, an ornament which resembles the leaves of a plant so called. It is used in the capitals of the Corinthian and Composite orders, and is said to have been introduced into the former by Callimachus, an Athenian architect, who was struck with the beauty of the leaves surrounding a basket, which, covered with a tile, had been left so near the plant that the leaves had grown over it.

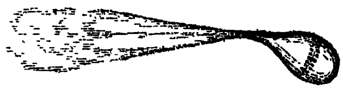
"The preceding cut shows the plant in its growing state; the following represents the front and side views of the leaf as an architectural ornament.

"Æolipile. A ball or vessel in which water can be converted into steam, and which allowing the steam to escape by two opposite orifices, by pipes connected with it, communicates motion to the ball. It was invented by Hero, and is the origin of that mighty instrument, the steam engine.

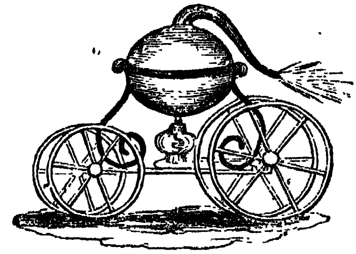
"A is a cauldron in which water is heated. The steam ascends through B and C into the ball D, escaping by the orifices E E; of course the ball must be supported in such a manner upon the pipes C B as to have freedom of motion around them, as an axis, yet that this part shall be steam tight.



"A philosophical toy is made under this name: it consists of a small ball of metal, with an exceedingly narrow tube and orifice—this ball is filled with spirits of wine. It is made to boil rapidly by a spirit lamp held beneath it; the steam will of course rush out, sometimes to the distance of 2 or 3 feet, and this being set fire to produced a long and beautiful jet of flame.

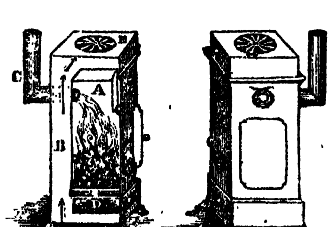


"A ball of this description is sometimes mounted on four wheels, which bear also the spirit lamp. If the ball be filled with water, and this made to boil, the steam will, if directed into the air at the back of the carriage, by its counter-action, impel the whole along the table, forming the first and simplest steam locomotive carriage.



"An instrument similar to the above, but on a large scale, is used occasionally as a bellows, to increase the draught of a steam-engine furnace; also the alcoholic blow-pipe is upon a similar construction.

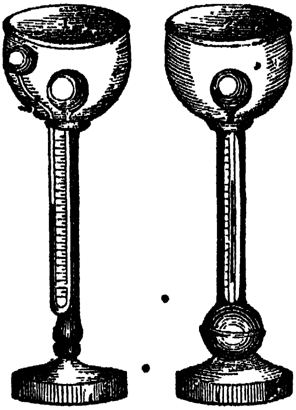
"Air Stove. An inclosed fire-place, so constructed as to admit a stream of air to pass round it, or through it; and this impinging upon heated surfaces is rarefied, carried upwards, and warms the apartment. There are numberless modifications of this principle, but they all may be reduced to two. First, such as admit the air to play against metal, which is heated by a direct fire. The second pass the stream of air through a cylinder of steam. The following cut represents one of the first kind, seen both in elevation and in detail:—



"A is a square cast-iron box, closed at top, and open only at the bars at bottom, to let out the ashes; and let in the stream of air that keeps up the combustion. Opening also in front with a door to supply fuel, and having a pipe C as a chimney. B is a cast-iron case, entirely surrounding A. There is a drawer below to catch the ashes. The air enters at bottom between the two cases; it passes upwards, touching the outside of A, and thereby becoming heated, escapes through the top E, where

is a register to regulate the draught of air required to heat the apartment, as there is also in the front of D to regulate that appertaining to the fire. If it be required to warm an apartment distant from that in which the stove is placed, a pipe is affixed to the top of the stove, instead of the register, and this pipe carried to the required situation.

"ÆTHRIOSCOPE is an instrument invented by Professor Leslie, on the principle of the differential thermometer, to indicate cold pulsations of the air, and which Dr. Brewster says is so delicate, that the liquor in the stem rises and falls with every passing cloud. The annexed cut (No. 1,) is a representation of the original instrument. The cut, (No. 2,) is a simplification of it as proposed by Dr. Brewster. No. 1 consists of a metallic cup, of the shape given, and made of thin brass or silver, polished on the inside, and from 2 to 4 inches diameter. In the focus of this is placed one of the balls of a differential thermometer, the diameter of which ball is equal to one-third that of the cup. The other ball is bent so as to be as much as possible out of the way, that it may not be subject to a like influence, a lid of metal is put over the cup, and only removed when an experiment is to be made. The scale may extend 60 or 70° above zero, and about 15° below it.



"Fig. 2 is the same, as to the cup, cover, and sentient ball, but the tube is straight, and the second ball is inclosed in the foot of it. When used, the instrument is to be placed a few feet above the earth, that it may not be affected by terrestrial radiation. It may also be remarked, that this instrument would be of much more general application, if it were fixed upon an axis, or had a joint near the foot, that it might be directed to any particular part of the heavens, and not confined to a perpendicular impulse, as at present."

PREPARATION OF FEATHERS.

FEATHERS constitute the subject of the manufacture of the *Plumassier*, a name given by the French (and also the English) to the artizan who prepares the feathers of certain birds for ornaments to the toilette of ladies and for military men, and to him also who combines the feathers in various forms. We shall content ourselves with describing the method of preparing ostrich feathers, as most others are prepared in the same way.

Several qualities are distinguished in the feathers of the ostrich; those of the male, in particular, are whiter and more beautiful. Those upon the back and above the wings are preferred; next, those of the wings, and lastly, of the tail. The down is merely the feathers of the other parts of the body, which vary in length from 4 to 14 inches. This down is black in the males, and grey in the females. The finest white feathers of the female have always their ends a little greyish, which lessons their lustre, and lowers their price. These feathers are imported from Algiers, Tunis, Alexandria, Madagascar, and Senegal; this being the order of their value.

The *scouring process* is thus performed:—4 ounces of white soap, cut small, are dissolved in 4 pounds of water, moderately hot, in a large basin; and the solution is made into a lather by beating with rods. Two bundles of the feathers, tied with packthread, are then introduced, and are rubbed well with the hands for five or six minutes. After this soaping they are washed in clear water, as hot as the hand can bear.

The whitening or bleaching is performed by three successive operations.

1. They are immersed in hot water mixed with Spanish white, and well agitated in it; after which they are washed in three waters in succession.

2. The feathers are azured in cold water containing a little indigo tied up in a fine cloth. They should be passed quickly through this bath.

3. They are sulphured in the same way as straw hats are; they are then dried by hanging upon cords, when they must be well shaken from time to time to open the fibres.

The ribs are scraped with a bit of glass cut circularly, in order to render them more pliant. By drawing the edge of a blunt knife over the filaments they assume the curly form so much admired. The hairs of a dingy color are dyed black. For 20 pounds of feathers, a strong decoction is made of 25 pounds of logwood in a proper quantity of water. After boiling it for 6 hours, the wood is taken out, 3 pounds of copperas are thrown in; and, after continuing the ebullition for 15 or 20 minutes, the copper is taken from the fire. The feathers are then immersed by handfuls, thoroughly soaked, and worked about; and left in for two or three days. They are next cleansed in a very weak alkaline lye, and soaped three several times. When they feel very soft to the touch, they must be rinsed in cold water, and afterwards dried. White feathers are very difficult to dye a beautiful black. The acetate of iron is said to answer better than the sulphate, as a mordant.

For dyeing other colors, the feather should be previously well bleached by the action of the sun and the dew; the end of the tube being cut sharp like a tooth-pick, and the feathers being planted singly in the grass. After fifteen days' exposure, they are cleared with soap as above described.

Rose color or *pink*, is given with safflower and lemon juice.

Deep red, by a boiling hot bath of Brazil wood, after aluming.

Crimson. The above deep red feathers are passed through a bath of cudbear.

Prune de Monsieur. The deep red is passed through an alkaline bath.

Blues of every shade, are dyed with the indigo vat.

Yellow; after aluming, with a bath of turmeric or weld.

Other tints may be obtained by a mixture of the above dyes.

Feathers have some more useful employments than the decoration of the heads of women and

soldiers. In one case, they supply us with a soft elastic down on which we can repose our wearied frames, and enjoy sweet slumbers. Such are called *bed* feathers. Others are employed for writing, and these are called *quills*.

Goose feathers are most esteemed for beds, and they are best when plucked from the living bird, which is done thrice a year, in spring, midsummer, and the beginning of harvest. The qualities sought for in bed feathers, are softness, elasticity, lightness, and warmth. Their only preparation when cleanly gathered are a slight beating to clear away the loose matter, but for this purpose they must be first well dried either by the sun or a stove. Bleaching with lime water is a bad thing, as they can never be freed from white dust afterwards.

The feathers of the eider duck, *anas mollissima*, called eider down, possesses in a superior degree all the good qualities of goose down. It is used only as a covering to beds, and never should be slept upon, as it thereby loses its elasticity.

Quills for writing. These consist usually of the feathers plucked out of the wings of geese. Dutch quills have been highly esteemed, as the Dutch were the first who hit upon the art of preparing them well, by clearing them both inside and outside from a fatty humour with which they are naturally impregnated, and which prevents the ink from flowing freely along the pens made with them. The Dutch for a long time employed hot cinders or ashes to attain this end; and their secret was preserved very carefully, but it at length transpired, and the process was then improved. A bath of very fine sand must be kept constantly at a suitable temperature, which is about 140° Fah.; into this, the quill end of the feather must be plunged, and left in it a few instants. On taking them out they must be strongly rubbed with a piece of flannel, after which they are found to be white and transparent. Both carbonate of potash in solution and dilute sulphuric acid have been tried to effect the same end, but without success. The yellow tint which gives quills the air of age, is produced by dipping them for a little in dilute muriatic acid, and then making them perfectly dry. But this process must be preceded by the sand-bath operation. The above is the French process.

Quills are dressed by the London dealers in two ways; by the one, they remain of their natural color; by the other, they acquire a yellow tint. The former is called the Dutch method, and the principal workman is called a Dutcher. He sits before a small stove fire, into which he thrusts the barrel of the quill for about a second, then lays its root quickly below his blunt-edged knife called a hook, and pressing this firmly with the left hand, draws the quill briskly through with his right. The bed on which the quill is laid to receive this pressure is called the plate. It is a rectangular smooth lump of iron, about 3 inches long, 1½ broad, and 2½ thick, which is heated on his stove to about the 350th° F. The hook is a ruler of about 15 inches in length, somewhat like the patten-makers' knife, its fulcrum being formed at the one end by a hook and staple, and the power of pressure being applied by the hand at the other end. The quill, rendered soft and elastic by the heat, endures the strong scraping action of the tool, and thus gets stripped of its opaque outer membrane, without hazard of being split. A skilful workman can pass 2000 quills through his hands in a day of 10 hours.

They are next cleaned by being scrubbed by a woman with a piece of rough dog-fish skin, and finally tied up by a man in one quarter of hundred bundles.

In another mode of dressing quills, they are steeped a night in decoction of turmeric, to stain them yellow; taken out and dried in warm sand contained in a pot, then scraped by the Dutcher as above described. The first are reckoned to make the best pens, though the second may appear more beautiful.

Crow quills for draughtsmen, as well as swan quills, are prepared in the same way. The quills plucked from well-fed living birds have most elasticity, and are least subject to be moth-eaten. The best are those plucked, or which are spontaneously cast in the month of May or June, because they are then fully ripe. In the goose's wing the five exterior feathers only are valuable for writing. The first is the hardest and roundest of all, but the shortest. The next two are the best of the five. They are sorted into those of the right and the left wing, which are differently bent. The heaviest quills are, generally speaking, the best. Lately, steaming for four hours has been proposed as a good preparation.

GENERAL EFFECTS OF HEAT.

(Resumed from page 301, and concluded.)

Specific Heat.—Different bodies are differently susceptible of the effects of heat. To produce a given change of temperature in some, requires a greater supply of heat than in others. Thus, to raise water from the temperature of 50° to the temperature of 60°, will require a fire of given intensity to act upon it about thirty times as long as to raise the same weight of mercury through the same range of temperature. In the same manner, if various other bodies be submitted to a like experiment, it will be found that to produce the same change of temperature on the same weights of each, will require the action of the same fire for a different length of time.

The quantities of heat necessary to produce the same change of temperature, in equal weights of different bodies are therefore called the *specific heats* of these bodies. If 1000 express the specific heat of pure water, or the quantity of heat necessary to raise a given weight of pure water through 1°, then 32 will express the specific heat of mercury, or the quantity of heat necessary to raise the same weight of mercury through 1°; 70 will express the specific heat of tin; 80 of silver; 110 of iron; and so on. The specific heat furnishes another physical character by which bodies, whether simple or compound, of different kinds, may be distinguished.

The specific heat of the same body is changeable with its density. In general, as the density is increased, the specific heat is diminished. Now, if the specific heat of a body be diminished, since a less quantity of heat will then raise it through 1° of temperature, the quantity of heat which it actually contains will make it hotter when it is rendered more dense and colder when it is rendered more rare.

Hence we find, that when certain metals are hammered, so as to increase their density, they become hotter, and sometimes become red-hot.

If air be squeezed into a small compass, it becomes so hot as to ignite tinder; and the discharge of an air-gun is said to be accompanied by a flash of light in the dark.

On the other hand, if air expand into an enlarged space, it becomes colder. Hence, in the upper regions of the atmosphere, where the air is not compressed, its temperature is much reduced, and the cold becomes so great as to cause, on high mountains, perpetual snow.

The specific heats of compounds frequently differ much from those of the constituents. If the specific heat of bodies be greatly diminished by their combination, then the quantity of heat which they contain will render the compound much hotter than the components before the combination took place. If, on the other hand, the specific heat of the compound be greater than that of the components, then the compound will be colder, because the heat which it contains will be insufficient to sustain the same temperature.

Hence we invariably find that chemical combination produces a change of temperature. In some cases cold is produced, but in most cases a considerable increase of temperature is the result.

Propagation of Heat.—Heat is propagated through space in two ways. First, by radiation, which is apparently independent of the presence of matter; and, secondly, by conduction,—a word which expresses the passage of heat from particle to particle of a mass of matter.

Radiation.—The principal properties of heat are so nearly identical with those of light, that the supposition that heat is obscure light is countenanced by strong probabilities. Heat proceeds in straight lines from the points whence it emanates, diverging in every direction. These lines are called *rays* of heat, and the process is called *radiation.* Heat radiates through certain bodies which are transparent to it, as glass is to light. It passes freely through air or gas: it also passes through a vacuum; and, therefore, its propagation by radiation does not depend on the presence of matter. Indeed the great velocity with which it is propagated by radiation proves that it does not proceed by transmission from particle to particle.

The rays of heat are reflected and refracted according to the same laws as those of light. They are collected in foci, by concave mirrors and by convex lenses. These undergo polarisation, both by reflection and refraction in the same manner as rays of light. They are subject to all the complicated phenomena of double refraction by certain crystals in the same manner exactly as rays of light.

Certain bodies possess imperfect transparency to heat: such bodies transmit a portion of the heat which impinges on them, and absorb the remainder, —the portions which they absorb raising their temperature.

Surfaces also possess the power of reflecting heat in different degrees. They reflect a greater or less portion of the heat incident on them, absorbing the remainder. The power of transmission, absorption, and reflection, vary according to the nature of the body and state of its surface, with respect to smoothness, roughness, and color.

Rays of heat, like those of light, are differently refrangible, and the average refrangibility of calorific rays is less than that of luminous rays.

Conduction.—When a body at a high temperature, as the flame of a lamp or fire, is placed in contact with the surface of a solid, the particles immediately in contact with the source of heat receive an elevated temperature. These communicate heat to the contiguous particles, and these again to particles more remote. Thus the increased temperature is gradually transmitted through the dimensions of the body, until the whole mass in contact with the source of heat has attained the temperature of the body in contact with it.

Different substances exhibit different degrees of facility in transmitting heat through their dimensions in this manner. In some the temperature spreads with rapidity, and an equilibrium is soon established between the body receiving heat and the body imparting it. Such substances are said to be *good conductors* of heat. Metals in general are instances of this. Earths and woods are bad conductors; and soft, porous, or spungy substances, still worse.

Relations of Heat and Light. Incandescence.—When the temperature of a body has been raised to a certain extent, by the application of any source of heat, it is observed to become luminous, so as to be visible in the absence of other light, and to render objects around it visible. Thus, a piece of iron, by the application of heat, will at first emit a dull red light, and will become more luminous as its temperature is raised, until the red light is converted to a clear white one, and the iron is said to be *white-hot.* This process, by which a body becomes luminous by the increase of its temperature, is called *incandescence.*

There is reason to believe that all bodies begin to be luminous when heated to the same temperature.

The degree of heat of incandescent bodies is distinguished by their color: the lowest incandescent heat is a red heat; next the orange heat, the yellow heat, and the greatest a white heat.

The heating power of rays of light varies with their color; in general, those of the lightest color having the most heating power. Thus, yellow light has a greater calorific power than green, and green than blue.

Hence the absorption of heat from the same light depends on the color of the absorbing bodies. Those of a dark color absorb more heat than those of a light color, because the former reflect the least calorific rays.

Combustion.—There are several substances which when heated to a certain temperature acquire a strong affinity for oxygen gas; and when this elevation of temperature takes place in an atmosphere of oxygen, or in ordinary atmospheric air, the oxygen rapidly combines with the heated body, and in the combination so great a quantity of heat is evolved that light and flame are produced. This process is called *combustion.* Combustion is therefore a sudden chemical combination of some substance with oxygen, attended by the evolution of heat and light. The flame of a candle or lamp is an instance of this. The substance in the wick having its temperature raised in the first instance by the application of heat, forms a rapid combination with the oxygen of the atmosphere, and this combination is attended with the evolution of heat, which sustains the process of combustion.

Flame is therefore gaseous matter rendered so hot as to be luminous. There are a few other substances besides oxygen, by combination with which light and heat may be evolved, and which may therefore produce combustion. These are the substances called in chemistry, chlorine, iodine, and bromine; but as they are not of common occurrence, the phenomenon of combustion attending them may be regarded rather as a subject of scientific inquiry than of practical recurrence. All ordinary cases of combustion are examples of the combination of oxygen with a combustible.

Sensation of Heat.—The senses which are the first means by which we learn the presence of heat, are the most inaccurate means of estimating its quantity. An object *feels* warm, when it imparts heat to us on touching it; and one object feels warmer than another, when it imparts heat with more abundance or rapidity. On the other hand, an object *feels* cold, when it abstracts heat from us on touching it; and one object feels colder than another, when it abstracts more heat on being touched.

Whatever imparts heat to us must have a higher temperature than our bodies, and whatever abstracts heat must have a lower temperature. Hence the sensation of heat or cold is relative to the temperature of the human body, and not dependent on the absolute temperature of the body which we touch.

But a good conductor of heat at the same temperature will impart heat more freely, and abstract it more abundantly and rapidly, than a bad conductor. Hence a good conductor will feel hotter or colder than a bad conductor, though their actual temperatures be the same. A multitude of wrong notions respecting the temperature of objects which we touch arises from these circumstances.

Sources of Heat.—Theories of Heat.—The sources from which heat are derived are the following:—

I. Solar Light.

II. Electricity.

III. The Condensation of Vapour, and Solidification of Liquids.

IV. Percussion, Compression, and Friction.

V. Chemical Combination.

VI. Animal Life.

Two theories have been proposed respecting the nature of heat.

1. Heat is regarded as an extremely subtle fluid which pervades all space, entering into combination in various proportions and quantities with bodies, and producing by this combination the effects of expansion, fluidity, vaporisation, and all the other phenomena.

2. Heat is regarded as the effects of a certain vibration or oscillation produced either in the constituent molecules of bodies, or in a subtle imponderable fluid which pervades them.

MIGRATION OF BUTTERFLIES.

In a paper read by M. Schomburg to the Entomological Society, on the migration of butterflies *(Papilio)*, in British Guiana.; Mr. S. detailed some curious facts relative to the great number of butterflies (of which he could distinguish three kinds) he had observed during his travels in British Guiana, at certain seasons. On one occasion when ascending the river Berbice, a flight of butterflies crossed the river from the plains, and all taking one course, viz., from the south-west to the north-east. From computations he then made, he is convinced that in 9½ hours no less than 17,100 butterflies must have passed over a single spot, and that at least fifty-three hundreds of millions must have passed over him during his day's journey. The caterpillars of these insects likewise abound in the proper season, and create great devastation to the herbage on which they feed. The tawny natives mix the caterpillars with flour, and make an excellent bread, some of which Mr. S. has eaten; they likewise eat them mixed with the eggs of the turtle.

The president then made some observations on the subject, and stated that migrations of a similar character had been noticed by Sir R. K. Porter, in South America, and Dr. Horsfield, in India. They have also been observed in Switzerland, and Mr. Westwood has witnessed a similar fact in England, after damp rainy weather. Mr. Gould, who has recently returned from Australia, stated that he had seen a small caterpillar in that country in great numbers, covering a space of a mile and a half in extent—they always follow a fertile season, and especially after rain, when they devour every herb within their reach, such as tobacco, and even the vineyards are sometimes damaged by them. They are preyed upon by hawks, Mr. Gould having seen 500 on a plain at one time feeding off them. He has eaten those obtained from the gum trees when roasted, and states them to be good eating—they are partaken of by the natives.

MISCELLANIES.

Ink Prepared with Prussian Blue.—This substance, so beautiful in color, which now rivals indigo, since it is used for dyeing silk and woollen, has not hitherto a proper solvent. The solvent employed is a vegetable acid, possessing a powerful discoloring property,—oxalic acid, which is the agent which effects the solution. In order to prepare this ink, which is capable of taking the greatest variety of shades, from the deepest blue-black to the lightest cœrulean blue, it is necessary to pound with care the coloring matter with a sixth part of crystallised oxalic acid mixed with a little water, so as to form it into a very fine mixture; then to dilute it with rain water, slightly gummed. The quantity of water added should be larger or smaller according to the shade required. When the solution is in the least degree concentrated the ink is of an extremely deep blue. Unfortunately this ink is not secure from the action of different chemical agents, such as pearl-ashes, &c. The inventors, MM. Stehu and Nash have, notwithstanding, taken out a patent for it.—*Inventors' Advocate.*

Action of Sea-water on Glass.—At a meeting of the Philosophical Society of St. Andrew's, on Monday, Sir David Brewster exhibited a bottle of wine from the Royal George, which had been exposed to the action of sea water. This bottle he received from Mr. Lyell, of Kinnerdy, for the purpose of examining the remarkable decomposition of the glass produced by the action of salt water. The thin films of glass which covered the bottle like a silvery incrustation had all the properties of the brilliant scales of decomposed glass found in Italy, and produced by nearly 2,000 years' exposure to the elements. Upon a careful examination of the surface of the bottle, Sir David found that the scales were throughout filled with veins like those of agate, and coincided with the lines in which the glass had been twisted in the mechanical operation of forming the bottle. The lines in which the cohesion of the particles of the glass was the least were the soonest decomposed by the action of the sea water. This curious fact disclosed the cause of the similarly waved structure in the decomposed glasses of Greece and Rome.—*Scotsman.*

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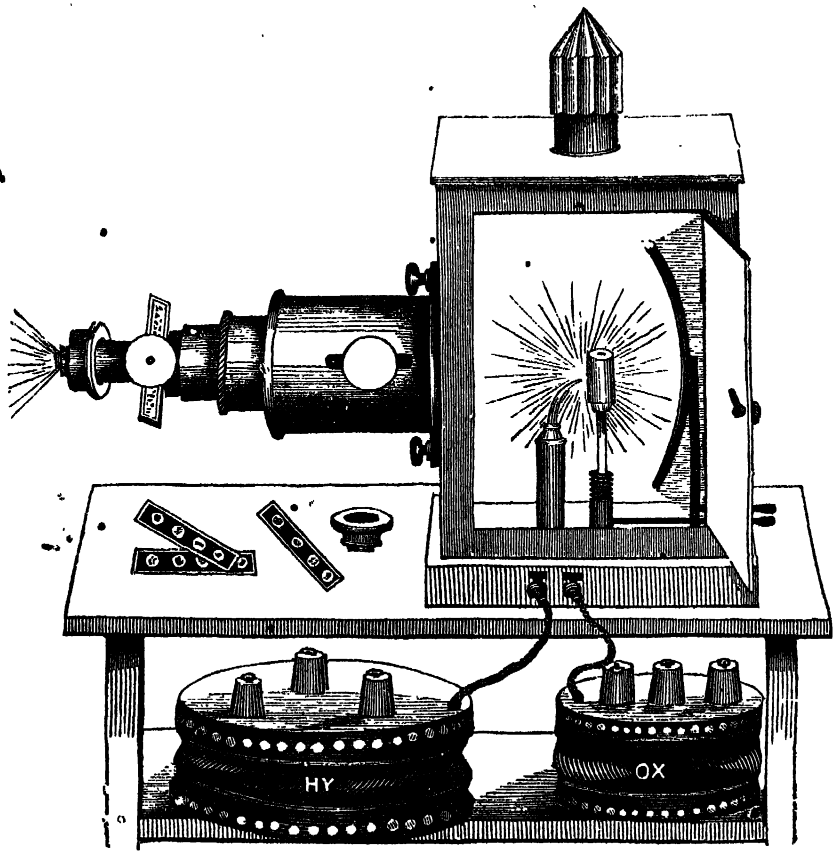
Fig. 1.



THE OXY-HYDROGEN MICROSCOPE.

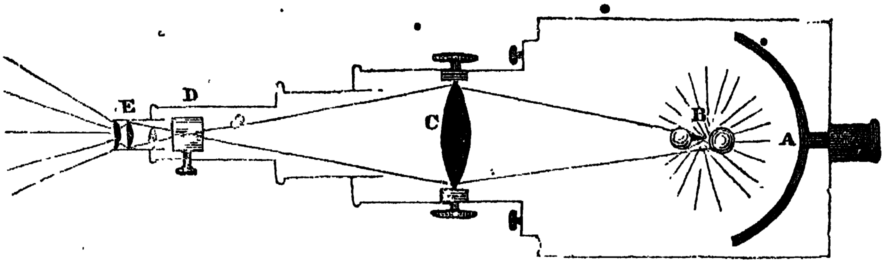


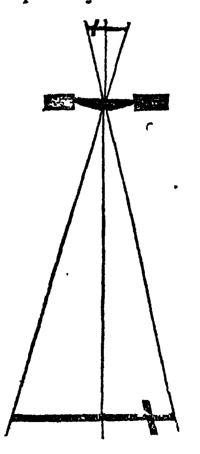
Fig. 2.

THE OXY-HYDROGEN MICROSCOPE.

The oxy-hydrogen microscope, so attractingly exhibited in the present day, and unquestionably meriting all the encouragement that can possibly be bestowed, upon it by the promoters of rational instruction, may be considered as a modification of the solar, adapted to receive, and employ to the greatest advantage, the rays of an artificial light diverging from a central point, instead of the parallel rays from the sun. In the year 1821, Dr. Birkbeck delivered two lectures on optical instruments at the London Mechanics' Institution; in one of which he took occasion to delineate on a screen, by means of a large magic lantern, representations of magnified objects intensely illuminated by the light emitted during the combustion of lime by hydrogen and oxygen gases, and to indicate the practicability of applying successfully this method of illumination to the microscope. About the same time, also, Mr. Woodward instituted some experiments with the phantasmagoria, where the light was obtained in the same way. In the interval between that and the present time, various amateurs and artists have studiously exercised their talents in perfecting the several parts of the instrument, which, like the solar, assumes its name from the source whence the light requisite to its action is derived.

An oxy-hydrogen microscope may be defined to be an instrument adapted to throw upon a screen a correct and magnified image of any object, placed properly between the light and lens. Of all optical instruments it is the most simple; the optical part consisting of but a single lens, or if more than one it is only because a single lens refracts the light unequally, and thereby occasions a distorted, as well as a colored image, as afterwards explained.

If we take a common convex lens, as shown below, and place an object strongly illuminated before it, so that an image of it may be projected downwards, that image of it will be an inverted magnified representation of the object. By a little consideration it will be evident, that all that portion of the light emanating from the object, which conduces to form the picture below, must pass through the aperture of the lens—the surplus rays



being entirely obstructed and cut off. Now, in proportion as the picture is enlarged, the available portion of the light will be spread over a larger surface, and consequently the picture will be more and more diluted. To remedy this defect, it would seem that you have only to extend the aperture of the lens by substituting one of a greater diameter, which shall transmit an additional quantity of light; but, by doing this, the following evils will arise:—

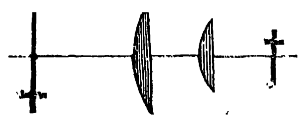
I. The aberration occasioned by the spherical figure of the lens will be greatly increased, and the image will be less defined

II. The dispersion arising from the unequal refrangibility of the light will produce a strong coloring throughout the image.

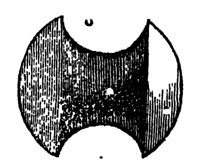
III. The aberration of the oblique pencils will cause indistinctness and color around the edges of the field of view.

IV. The image being formed in a caustic curve, and not in a plane, it will not be distinct in all its parts on a flat screen, with the same adjustment of the instrument.

To correct these defects, it is necessary to have a combination of lenses rather than one only; and without entering now into the theory of lenses, it is sufficient to state that such a combination of them as the following will be that best adapted to correct the three first, and as to the last, that of the image



being equally clear and well defined only when thrown upon a curved surface, it is necessary that one if not both of the lenses should be curved like the glasses used for a watch, as was explained in treating of camera obscura in No. 1, or else what is denominated the Codrington lens, which consists of a sphere of glass or crystal with the equatorial parts ground away as follows:—



Thus, as to the magnifying power for a common instrument nothing is requisite but a plane convex glass, the flat side being turned towards the object. For a better apparatus a combination of two such glasses is requisite, and for one still better a Codrington lens—the focus or magnifying power being according to the field of view required, distance of screen, &c.

This is supposing that the light passes immediately from the burner to the object—but it is evident that the further light has to travel, the less intense it will shine upon any particular spot; therefore it is advisable to condense the light upon the object, either by means of a reflector behind the light, or else by a lens in front of it. Each method has its advocates. In the Figure on our front page we have represented both, and the whole section of the optical part of the instrument will be as depicted in Fig. 2—in which it is supposed that you look down upon the instrument, getting thereby a view of the screws which regulate the focus of the condensing lens. A is the reflector; B, the light; C, the condensing lens; D, the hole for the object; E, the eye piece.

The next consideration is the light and its ma-

nagement. The structure of that part of the apparatus which refers to this is seen in Fig. 1. OX and HY represent two receivers for gas; that for hydrogen, HY—being twice the capacity of the other, that being the proportion in which the gases will be required. To each of these receptacles is a tube and stop-cock, to admit the gas into the small cylinder above them; this cylinder is hollow, and filled with fine needles driven tightly in, so as to make a complete and safe oxy-hydrogen blow-pipe —the construction of several kinds of which we have long ago described. On the top of the cylinder is screwed a cylindrical piece of lime, about 1 inch long and ½ an inch in diameter, having a hole bored through it, though this is by no means necessary, as the lime may be of any shape, and supported in any convenient manner. It is usually, however, made cylindrical that the distance between the blowpipe jet and the lime may be always equal: and this is more especially convenient, because after a few minutes burning, a hole will be made in the lime, and the light thereby impaired—to prevent which, the rod which supports the lime is made to turn round by a screw underneath, that a fresh surface may always be ready, and with little trouble; so also the part which supports the lime should be made to slip backwards and forwards in a slight degree.

Such is the structure of the oxy-hydrogen microscope; its particular management, as well as a remark or two on screens, we are obliged to defer till next week.

PREPARATION OF PIGMENTS.

(Resumed from page 280, and concluded.)

BLACK.

The blacks used in painting are generally made from animal or vegetable carbon; but fossil black is occasionally employed.

Ivory Black is formed by calcining the parings of that substance, left by the workmen's tools; it is very deep in tone, and transparent. Bone black, carefully prepared, differs little from the last; it is a little warmer in tone, and may be made quite brown, if the carbonizing is stopped ere it is completed; this brown is very transparent, but it must be ground in drying oil, or it will not dry.

Charcoal black has less intensity than ivory or bone, and is less transparent; and the tints it produces are rather blueish. It is prepared by calcining in a close vessel the shells and husks of peaches, apricots, nuts, the cuttings of vines, and other young woods; there is not much difference in the tints of these various sorts; that which grinds the finest, is to be preferred. In this respect, the preference is due to the Liege charcoal, which is easily ground; whilst charcoal from peach stones, vines, and most sorts of wood, are on account of their elasticity, difficult to reduce to the tenuity of the other colors.

Liege black is prepared by calcining the above in a close crucible, and then washing it in boiling water, to carry off the soluble salts which it contains.

In a similar way is prepared the coffee black, from the husks of coffee; its properties are similar to the last.

WHITE LEAD.

The only white now used in oil painting, is a combination of protoxide of lead and carbonic acid; it is called in chemistry "the sub-carbonate of lead." From the various modes of preparing it, arises a very great diversity in the qualities; these are known by the names of ceruse, flake white, krems white, and silver white.

The ceruse made in Holland has long had the reputation of being the best in that class of whites. It is not a very clear white, and is therefore used chiefly in house painting, and in priming cloths for pictures: it is often mixed with chalk. The German ceruse contains a large proportion of the sulphate of barytes, but the Dutch ceruse of the first quality is pure.

Flake White is brighter than ceruse; it would even equal that of krems, if proper care was employed in its fabrication. It has the great advantage of not being liable to adulteration: it is called by the colormen "common white."

These two species of white are prepared by exposing plates of lead to the action of vinegar steam and carbonic acid. For this purpose, earthen vessels, either glazed or hard baked, are employed; slips of wood are laid across these, and the lead in plates, or spiral forms, is placed upon them, so as not to touch the liquid which fills the bottoms of the vessels. These pots are then ranged in lines, close together, upon a bed of stable dung. Other lead being placed as tiles upon those pots, some planks are laid over them; on these is placed another layer of dung, and on this another range of pots is placed, covered with lead in like manner; and thus it proceeds until the pile is six or eight feet high, as the localities may permit. To prevent the heat from becoming too powerful, openings are reserved in the layers, at proper distances, through the mass. These are usually close, but opened occasionally to examine the temperature: when that is too high, a current of air is allowed to pass through, until the heat is brought down to the standard required, which should not exceed 100 or 112° Fahr., at the most, unless it may be towards the close of the operation, when it is only required to dry the carbonate which has been formed.

In about six weeks the pots are removed, and the laminæ which cover them have become hard flakes, which, without further preparation, is the flake white of commerce. The spirals are unrolled, and flakes of a smaller and more brittle nature are drawn from them. These are ground in water, under horizontal grinders; the produce is then washed, and allowed to settle; the water is drained off, until the deposit has acquired a thick consistency; it is then put into conical pots, and dried for use.

This is the way in which the Hollanders prepare their ceruse. Its want of brightness arises from a small portion of the metal not being thoroughly oxidized, and also from the use of litter which throws out vapours, by which the oxide is darkened as it is formed. This disadvantage may be obviated by using moistened straw, or common tan, for the couches: the flakes will then have a brilliant whiteness.

Krems White.—The addition of a substance to furnish carbonic acid is quite requisite in this preparation; but the heat of a stove is substituted for that of stable dung. The leaden plates are exposed in this process to the united vapours of vinegar and carbonic acid gas in deal boxes, the bottoms of which are made secure from leakage by varnish, or some resinous liquid. The leaves of lead are about the thickness of the 12th of an inch, are arranged in a zig-zag form upon laths, supported by a stronger

piece of wood placed across the interior of the box. The leaves are isolated from each other, and distant from the surface of the vinegar about 3 inches.

To produce the carbonic acid, the union of which is requisite in making white lead, a certain proportion of the lees of wine, or tartaric acid, is added to the vinegar.

The boxes are then closed, and placed upon a square tube containing warm air. This is carried around the workshop, and brings the temperature up to 100° Fahr., but must not go beyond this point, otherwise the vinegar would evaporate too rapidly, and much of it would be lost.

In about fifteen days the boxes may be opened, and if the process has been well conducted, a quantity of carbonate should be collected equal to the quantity of metal employed.

But as the white lead obtained by this operation has not the hardness of that obtained by the Dutch method, it need not be ground, and is made extremely fine by a very simple apparatus. This is composed of a large box, divided into nine compartments, decreasing in depth; the flakes are put into the highest division, being separated from the metal that has not been attacked; water is then turned on from a reservoir placed above the case, and the mass is well stirred with a stick. The water soon flows over, and runs into the second division, then into the third, and so on to the ninth.

It is supposed that the particles of white drawn off by the water are finer in proportion to the distance they have been carried; therefore the deposits in the lowest divisions are of the best quality. The divisions are then emptied of their contents into large vats; the white subsides in a little time, and, when drained of its liquid, is put into porous earthen vases, the square shape of which it retains when dry. This drying takes place in the same stove where the metal was converted into white lead.

Krems white is the brightest white that is used in oil: it has rather less body than flake white, because the particles are much finer: an equal weight of krems will cover a much greater space than flake white. When newly prepared, it gives out a strong smell of vinegar.

The mode of making the white is quite different in this process from what it is in the methods just described. The ceruse is prepared very quickly, by forming a precipitate, with carbonic gas, in a supersaturated solution of protoxide of lead. This solution is prepared by agitating, in a cold state, litharge and distilled vinegar; when this mixture is sufficiently concentrated, it is passed through a current of carbonic acid gas, which unites with the greater portion of the dissolved oxide of lead; the precipitate is collected, washed carefully, and then dried for use. The liquor floating on the top is vinegar, still holding in solution some prot-oxide of lead, which, being charged with more litharge, gives a similar precipitate, having lost nothing of its power. The carbonic acid employed is drawn from ignited charcoal, and, ere it is used in the solution, it is washed in a large quantity of water, by which means it deposits completely a quantity of ashes and oily hydrogen gas along with it, which would blacken the ceruse.

White lead is used only in oil painting, and even then it becomes blackish; and would at length return to the color of its dull metallic state, if it were not preserved by a couch of varnish from the action of hydro-sulphureous vapours, which float constantly, more or less, in the atmosphere.

White lead should, therefore, never be used in distemper painting. Luckily M. Thenard has found out a method of restoring them to their original whiteness, though darkened by contact with hydro-sulphureous vapours. That eminent chemist was consulted some years ago upon the means of restoring to their original whiteness the black spots which had formed upon a valuable drawing, by the changing of the white lead. He had just terminated his experiments upon the oxygenated water, of which he was the discoverer. Among the various uses of that water, he had ascertained its power of instantly converting the sulphuret of lead into sulphate of lead, which is white. He soon applied it practically; and touched upon the black spots of the drawing with a pencil dipped in weakly oxygenated water, and immediately restored it to its primitive state, without in the least altering the brownish tint of the paper.

ORGAN STOPS.

A COMPLETE organ has usually three sets of keys, of which the middle one is for the great organ, the lowest for the choir organ, and the uppermost (which seldom extends lower than F or G below middle C) for the *swell*.

The principal stops in the great organ are, the *diapasons*; the principal having been originally so called, not by organ players, but organ builders, who, finding it convenient to make this their standard for tuning the stops by, (it being a mean between the diapasons and fifteenth sesquialtera, &c.) might give it that name. The diapasons may therefore be considered as the two unisons and foundation of the whole mixture, and must always be drawn, no other stops being to be used without being joined with them, though they may themselves be used alone, and each without the concurrence of the other.

The open diapason, so called from the pipes being open at the tops, is the loudest of the two, but the bass pipes being generally slow in speaking, it is usual, as well to assist it in that respect, as to strengthen it, to join the stopt diapason with it, the pipes of which are generally stopt with wooden plugs at the tops, on which account they are softer toned, and but half the length of those of the open diapason.

The principal is tuned an octave above the diapasons, and is occasionally joined to them, as well to strengthen, as to render them more brilliant.

The twelfth, so called from being tuned twelve notes above the diapasons, (or a fifth to the principal) must never be drawn without the three foregoing stops, and also the fifteenth with it, which being higher than the twelfth, the effect of the succession of fifths, (between the principal and twelfth, which would be intolerable without the fifteenth above,) is thereby qualified, the octaves being greatly predominant, whilst at the same time the twelfth enriches the mixture, so that neither of these two stops should be drawn without the other.

The sesquialtera which is a compound stop, consisting of 3, 4, or 5 pipes, (according to the size and scheme of the organ) to each note, tuned in 3rds, 5ths, and 8ths, so that every note is a common chord; to prevent any mischievous effect from which this stop must never be used without the five preceding stops, or at least the diapasons and principal to qualify it. This mixture is sufficient whenever the full organ is directed to be used, and to

accompany the choral parts of services and anthems, in cathedrals. Where however the church or congregation is pretty large, the chorus may be made one degree louder by drawing the mixture or furniture which also consists of two or more ranks of pipes, but shriller than those of the sesquialtera, so that it should only be used in addition to that stop. The next degree of augmentation is made by using the trumpet instead of the furniture. This stop, when it does not render the organ too powerful for the voices, always improves as well as increases the chorus, as by being in unison with the diapasons, it strengthens the foundation, and thereby qualifies the 3rds and 5ths in the sesquialtera, &c. by rendering them less predominant.

So that there may be five different kinds of the full organ used, viz., the sesquialtera (with the five preceding stops)—2d, the furniture added to the sesquialtera.—3rd, the trumpet added instead of the furniture.—4th, the trumpet and furniture both added.—And 5th, the clarion added to the whole.

The cornet is also a compound stop, having five pipes to a note, tuned something like the sesquialtera; but as it is only a half, or treble stop, it ought never to be used in the full organ, but only with the diapasons. It may be proper to mention, that when the trumpet is used as imitative of the real trumpet, it is then only joined with the diapasons.

The choir organ, (vulgarly called the chair organ) usually consists of the following stops, viz.

The stopt diapasons, which for want of an open diapason to draw with it (the bass pipes of which are too large and powerful for a choir organ), may be joined with the dulciana, which, though the pipes are also open, and in unison with it, is yet much smaller and softer than the open diapason; it is however seldom carried down lower than the gamut. This stop (as its name implies) has a peculiar sweetness of tone, and may be used quite alone.

The flute of which the pipes are stopt, and in unison with the principal, but softer. This is also frequently used alone, (as an imitation of the common flute or flageolet) but is more properly joined with the diapason, which two stops (with the dulciana at pleasure) are the proper accompaniment in solo or verse parts of anthems, the principal being too loud for that purpose, except when the voices are unsteady, and require to be led.

The bassoon, which is in unison with the diapason, and dulciana, with which only it must be joined, when used as a fancy stop in voluntaries.

Some organs have a vox humane, or cremona, or cromhorn, as it is sometimes called, instead of a bassoon, which stops should only be used with the diapason, (with which they are also in unison) and not in the full choir organ, as the bassoon may; the bass of the other two being very rough and disagreeable.

The only stops of the organ remaining to be described, is the swell, the usual stops in which are the two diapasons, which when used alone produce much the same effect as the dulciana in the choir organ; they are therefore generally joined at least with the principal. The most beautiful stops however in the swell are the hautboy and trumpet, which being in unison together, may be used either singly or both together, but always with the diapasons. To the whole of which may be added the cornet, which altogether makes what is called the full swell.

Having now described the several stops of the organ, it may not be amiss to observe, that the trumpet, clarion, bassoon, hautboy, vox humane, and cremona, are called reed stops, on account of the wind passing into them through a small brass tube, (called the reed,) to which is fixed a thin piece of brass, called the tongue, by the vibration of which their peculiarity of tone is occasioned.

INFINITE DIVISIBILITY OF MATTER.

Observation and experience prove that all bodies of sensible magnitude, even the most solid, consist of parts which are separable. To the practical subdivision of matter there seems to be no assignable limit. Numerous examples of the division of matter to a degree almost exceeding belief may be found in experimental inquiries instituted in physical science; the useful arts furnish many instances not less striking; but, perhaps, the most conspicuous proofs which can be produced, of the extreme minuteness of which the parts of matter are susceptible, arise from the consideration of certain parts of the organised world.

The relative places of stars in the heavens, as seen in the field of view of a telescope, are marked by fine lines of wire placed before the eye-glass, and which cross each other at right angles. The stars appearing in the telescope as mere lucid points without sensible magnitude, it is necessary that the wires which mark their places should have a corresponding tenuity. But these wires being magnified by the eye-glass would have rendered them inapplicable to this purpose, unless their real dimensions were of a most uncommon degree of minuteness.

Newton succeeded in determining the thickness of very thin laminæ of transparent substances by observing the colors which they reflect. A soap bubble is a thin shell of water, and is observed to reflect different colors from different parts of its surface. Immediately before the bubble bursts, a black spot may be observed near the top. At this part the thickness has been proved not to exceed the 2,500,000th of an inch.

The transparent wings of certain insects are so attenuated in their structure that 50,000 of them placed over each other would not form a pile a quarter of an inch in height.

In the manufacture of embroidery it is necessary to obtain very fine gilt silver threads. To accomplish this, a cylindrical bar of silver, weighing 360 ounces, is covered with about 2 ounces of gold. This gilt bar is then wire-drawn, until it is reduced to a thread so fine that 3400 feet of it weigh less than an ounce. The wire is then flattened by passing it between rollers under a severe pressure, a process which increases its length, so that about 4000 feet shall weigh 1 ounce. Hence, one foot will weigh the 4000th part of an ounce. The proportion of the gold to the silver in the original bar was that of 2 to 360, or 1 to 180. Since the same proportion is preserved after the bar has been wire-drawn, it follows that the quantity of gold which covers one foot of the fine wire is the 180th part of the 4000th of an ounce; that is, the 720,000th part of an ounce.

The quantity of gold which covers one inch of this wire will be twelve times less than that which covers one foot. Hence, this quantity will be the 8,640,000th part of an ounce. If this inch be again divided into 100 equal parts, every part will be distinctly visible without the aid of microscopes. The gold which covers this small but visible portion is the 864,000,000th part of an ounce. But we

may proceed even further; this portion of the wire may be viewed by a microscope which magnifies 500 times, so that the 500th part of it will become visible. In this manner, therefore, an ounce of gold may be divided into 432,000,000,000 parts. Each of these parts will possess all the characters and qualities which are found in the largest masses of the metal. It retains its solidity, the texture, and color, it resists the same agents, and enters into combination with the same substances. If the gilt wire be dipped in nitric acid, the silver within the coating will be dissolved, but the hollow tube of gold which surrounded it will still cohere and remain suspended.

The organised world offers still more remarkable examples of the inconceivable subtilty of matter.

The blood which flows in the veins of animals is not, as it seems, an uniformly red liquid. It consists of small red globules, floating in a transparent fluid called *serum*. In different species globules differ both in figure and in magnitude. In man and all animals which suckle their young they are perfectly round or spherical. In birds and fishes they are of an oblong spheroidal form. In the human species, the diameter of the globules is about the 4000th of an inch. Hence it follows, that in a drop of blood which would remain suspended from the point of a fine needle, there must be about a million of globules.

Small as these globules are, the animal kingdom present beings whose whole bodies are still more minute. Animalcules have been discovered, whose magnitude is such, that a million of them does not exceed the bulk of a grain of sand; and yet each of these creatures is composed of members as curiously organised as those of the largest species; they have life and spontaneous motion, and are endued with sense and instinct. In the liquids in which they live, they are observed to move with astonishing speed and activity; nor are their motions blind and fortuitous, but evidently governed by choice, and directed to an end. They use food and drink, from which they derive nutrition, and are therefore furnished with a digestive apparatus. They have great muscular power, and are furnished with limbs and muscles of strength and flexibility. They are susceptible of the same appetites, and obnoxious to the same passions, the gratification of which is attended with the same results as in our own species. Spallanzani observes, that certain animalcules devour others so voraciously, that they fatten and become indolent and sluggish by over-feeding. After a meal of this kind, if they be confined in distilled water, so as to be deprived of all food, their condition becomes reduced; they regain their spirit and activity, and amuse themselves in the pursuit of the more minute animals, which are supplied to them; they swallow these without depriving them of life, for, by the aid of the microscope, the one has been observed moving within the body of the other. These singular appearances are not matters of idle and curious observation. They lead us to inquire what parts are necessary to produce such results. Must we not conclude that these creatures have heart, arteries, veins, muscles, sinews, tendons, nerves, circulating fluids, and all the concomitant apparatus of a living organised body? And if so, how inconceivably minute must those parts be? If a globule of their blood bears the same proportion to their whole bulk as a globule of our blood bears to our magnitude, what powers of calculation can give an adequate notion of its minuteness?

MIGRATORY FISH.

Of all migrating animals, particular kinds of fishes make the longest journies, and in the greatest numbers. The multiplication of the species, and the procuring of food, are the principal motives of the migration of fishes. The salmon, a fish which makes regular migrations, frequents the northern regions alone. It is unknown in the Mediterranean sea, and in the rivers which fall into it both from Europe and Africa. It is found in some of the rivers of France that empty themselves into the ocean. Salmon are taken in the rivers of Kamtschatka, and appear as far north as Greenland. Salmon live both in the ocean and in fresh waters. For the purpose of depositing their spawn, they quit the sea in the month of September, and ascend the rivers. So strong is the instinct of migrating, that they press up the rivers with amazing keenness, and scarcely any obstacle is sufficient to interrupt their progress. They spring, with great agility, over cataracts of several feet in height. In their leaps, they spring straight up with a strong tremulous motion, and do not, as has been vulgarly supposed, put their tails in their mouths. When they find a place which they think proper for depositing their eggs, the male and female unite their labours in forming a convenient receptacle for the spawn in the sand, which is generally about eighteen inches deep. In this hole the female deposits her eggs, and the male his milt, which they are said to cover carefully with their tails; for, after spawning, their tails are deprived of skin. The eggs, when not disturbed by violent floods, lie buried in the sand till the spring, and they are hatched about the end of March. The parents, however, after this important office has been performed, hasten back to the sea, in order to cleanse themselves, and to recover their strength. Toward the end of March, the young fry begin to appear, and they gradually increase in size till they acquire the length of four or five inches, and are then called smelts, or smoults. About the beginning of May, all the considerable rivers of Scotland are full of salmon-fry. After this period, they migrate to the sea. About the middle of June, the earliest of the fry begin to appear again in the rivers. At that time they are from twelve to sixteen inches long, and gradually augment, both in number and size, till about the end of July or the beginning of August, when they weigh from six to nine pounds. This is a very rapid growth. But a gentleman of credit at Warrington informed Mr. Pennant of a growth still more rapid. A salmon, weighing seven pounds and three-quarters, was taken on the 7th day of February. It was marked on the back, fin, and tail, with scissars, and then turned into the river. It was retaken on the 17th day of the following month of March, and then it weighed seventeen pounds and a half. The season for fishing salmon in the Tweed begins on the 30th of November, and ends on Old Michaelmas-day. In that single river, it is computed that no less than 208,000, at a medium, are annually caught, which, together with the products of many other rivers on both sides of Scotland, not only afford a wholesome and palatable food to the inhabitants, but form no inconsiderable article of commerce.

Herrings are likewise actuated by the migrating principle. These fishes are chiefly confined to the northern and temperate regions of the globe. They frequent the highest latitudes, and are sometimes found on the northern coasts of France. They ap-

pear in vast shoals on the coast of America, as far south as Carolina. In Chesapeak Bay there is an annual inundation of herrings; and Mr. Catesby informs us, that they cover the shores in such amazing numbers as to become offensive to the inhabitants. The great winter rendezvous of the herrings is within, or near, the Arctic Circle, where they remain several months, and acquire strength after being weakened by the fatigues of spawning, and of a long migration. In these seas, insect food is much more abundant than in warmer latitudes. They begin their migration southward in the spring, and appear off the Shetland islands in the months of April and May. These, however, are only the forerunners of the immense shoal which arrives in June. Their approach is recognised by particular signs, such as the appearance of certain fishes, the vast number of birds, as gannets or solan geese, which follow the shoal to prey upon the herrings. But, when the main body arrives, its breadth and depth are so great as to change the appearance of the ocean itself. The shoal is generally divided into columns of five or six miles in length, and three or four in breadth. Their progressive motion creates a kind of rippling or small undulations in the water. They sometimes sink and disappear for ten or fifteen minutes, and then rise again toward the surface. When the sun shines, a variety of splendid and beautiful colors are reflected from their bodies. In their progress southward, the first interruption they meet with is from the Shetland islands. Here the shoal divides into two branches. One branch skirts the eastern, and the other the western shores, and fill every bay and creek with their numbers. Those which proceed to the west from Shetland, after visiting the Hebrides, where the great fishery is carried on, move on till they are again interrupted by the north of Ireland, which obliges them to divide a second time. One division takes to the west, where they are scarcely perceived, being soon lost in the immensity of the Atlantic Ocean. The other division goes into the Irish Sea, and affords nourishment to many thousands of the human race. The chief object of herrings migrating southward is to deposit their spawn in warmer and more shallow seas than those of the frigid zone. This instinct seems not to be prompted by a scarcity of food; for, when they arrive upon our coasts, they are fat and in fine condition; but, when returning to the ocean, they are weak and emaciated. They continue in perfection from the end of June to the beginning of winter, when they begin to deposit their spawn. The great stations of the herring fisheries are off the Shetland and the western islands, and along the coast of Norfolk.

Beside salmons and herrings, there are many fishes which observe a regular migration, as mackerels, lampreys, pilchards, &c. About the middle of July, the pilchards, which are a species of herrings, though smaller, appear in vast shoals off the coasts of Cornwall. When winter approaches, like the herrings, they retire to the Arctic seas. Though so nearly allied to the herring, it is not incurious to remark, that the pilchards, in their migration for the purpose of spawning, choose a warmer latitude; for, off the coasts of Britain, the great shoals never appear farther north than the county of Cornwall and the Scilly islands.

(To be continued.)

REMARKS ON COMETS.

1. Whether do comets shine with their own native light, or derive their light from the sun?—This is a question about which there have been different opinions, and at the present moment it may be considered as still undetermined, though the probability is, that in general, they derive their light from the same source as the planets. It appears to have been the opinion of both Schroeter and Herschel, that the comet of 1811 shone by inherent light; and the rapid variations which have been observed in the brightness of the nucleus, and the coruscations of the tail, are considered by some as inexplicable on any other hypothesis. It is likewise supposed that certain phenomena which have been observed in the the case of faint and rarefied comets tend to corroborate the same position. For example, Sir J. Herschel, on September 23rd, 1832, saw a small group of stars of the 16th and 17th magnitude through the comet of Biela. Though this group could have been effaced by the most trifling fog, yet they were visible through a thickness of more than 50,000 miles of cometary matter; and therefore it is supposed scarcely credible that so transparent a material, affording a free passage to the light of such minute stars, could be capable of arresting and reflecting to us the solar rays. On the other hand, it has been objected to this opinion, that comets have appeared as dark spots on the disk of the sun: that their light exhibits traces of *polarization;* and that they have been occasionally observed to exhibit *phases*. M. Arago remarks, that "on the very day that any comet shall appear with a distinct phase, all doubts on this subject will have ceased." But it is considered doubtful whether any *decided phase* has yet been perceived, although some observers were led, from certain phenomena, to infer that something like a phase was presented to their view. It is found that all direct light constantly divides itself into two points of the same intensity when it traverses a crystal possessing the power of double refraction; reflected light gives, on the contrary, in certain portions of the crystal through which it is made to pass, two images of unequal intensity, provided the angle of reflection is not 90°; in other words, it is *polarized* in the act of reflection. On this principle, M. Arago pointed out a photometrical method of determining whether comets borrow their light from the sun, or are luminous in themselves. On the 23rd of October, 1835, having applied his new apparatus to the observation of Halley's comet, he immediately saw two images presenting the complementary colors, one of them red, the other green. By turning the instrument half round, the red image became green, and *vice versa.* He concluded, therefore, that the light of the comet, at least the whole of it, is not composed of rays possessing the property of direct light, but consists of that which is *polarized* or reflected specularly; that is, of light derived from the sun. These experiments were repeated with the same result by three other observers in the Observatory of Paris.

2. It appears to be a remarkable fact in respect to comets, that the real diameter of the nebulosity increases porportionably as the comet *becomes distant* from the sun. Helvelius appears to have been the first who made this observation; but it seems to have been overlooked, and even an opposite position maintained. As the tails of comets increase in length as they approach their perihelia, so it was

generally considered that the nebulosities followed the same law; but the observations which have lately been made on Biela's comet have confirmed the observations of Helvelius. On the 28th of October, 1828, this comet was found to be nearly three times further from the sun than on the 24th of December, or in the proportion of 1·4617 to 0·5419, yet in October its diameter was about twenty-six times greater than in December or in the proportion of 79·4 to 3·1; that is, its solid contents on the 28th of October were 15,800 times greater than on the 24th of December, and the *smallest size* of the comet corresponded to its least distance from the sun. M. Valz, of Nimes, and Sir John Herschel have attempted to account for this circumstance on very different principles, but neither hypothesis appears to be satisfactory.

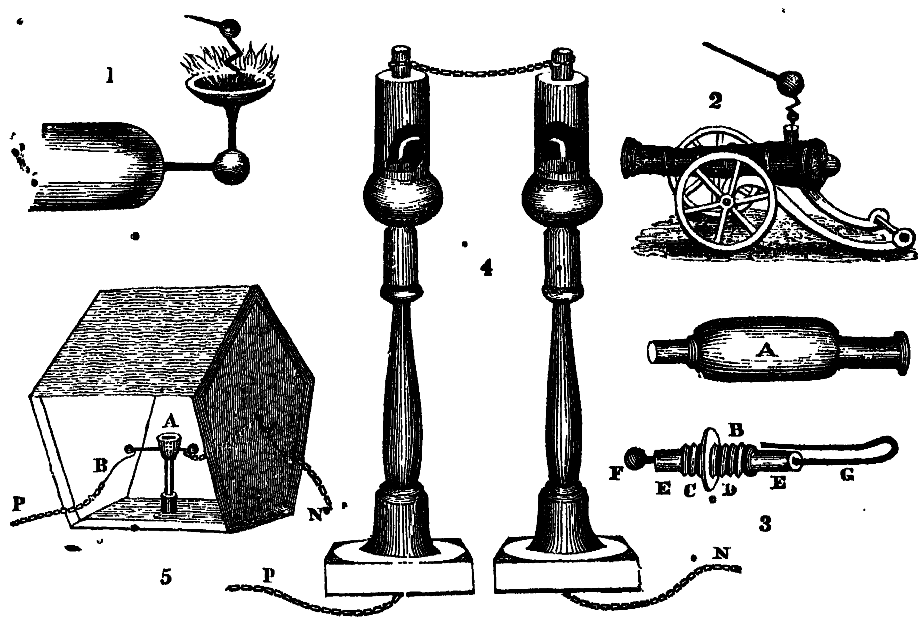
3. Whether a comet may ever come in contact with the earth, and produce a concussion?—As comets move in orbits which form extremely elongated ellipses; as they move in all imaginable directions; as they traverse almost every part of the solar system in returning from the furthest verge of their excursions; as they penetrate within the interior of the planetary orbits—even within the orbit of Mercury, and cross the orbits of the earth and the other planets, *it is not impossible* that a comet may come in contact with our globe. An apprehension of such an event produced a considerable degree of alarm on the Continent at different periods, particularly in 1773 and 1832. But when we consider the immense cubical space occupied by the planetary system in which the comets move, and compare it with the small capacities of these bodies; and when we take into view certain mathematical calculations in reference to the subject, the probability of a shock from a comet is extremely small. "Let us suppose," says Arago, "a comet of which we only know that at its perihelion it is nearer the sun than we are, and that its diameter is *one-fourth* of that of the earth, the calculation of probabilities shows that of 281,000,000 of chances there is only one unfavorable, there exists but one which can produce a collision between the two bodies. As for the *nebulosity*, in its most general dimensions, the unfavorable chances will be from ten to twenty in the same number of 281,000,000. Admitting then, for a moment, that the comets which may strike the earth with their nuclei would annihilate the whole human race, then the danger of death to each individual, resulting from the appearance of an *unknown* comet, would be exactly equal to the risk he would run if in an urn there was only one single white ball of a total number of 281,000,000 balls, and that his condemnation to death would be the inevitable consequence of the white ball being produced at the first drawing."

4. Another question occurs on this subject—namely, whether any comets have ever fallen into the sun? It was the opinion of Sir Isaac Newton that one purpose for which comets are destined is, to recruit the sun with fresh fuel, and repair the great consumption of his light by the streams continually emitted every way from that luminary; and that such comets as come very near the sun in their perihelions meet every time with so much resistance from his atmosphere as to abate their projectile force; by the constant diminution of which, the centripetal power, or gravitation towards the sun, would be so increased as to make them fall into his body. On a similar principle, Arago supposes that the comet of 1680, which approached so near the body of the sun, must have passed nearer to his surface at that time than at its preceding apparitions; that the decrease in the dimensions of the orbit will continue on each succeeding return to its point of perihelion; and that "it will terminate its career by falling upon the sun." But he acknowledges, that "from our ignorance of the densities of the various strata of the sun's atmosphere, of that of the comet of 1680, and of the time of its revolution, it will be impossible to calculate after how many ages this extraordinary event is to happen;" and he likewise admits that "the annals of astronomy do not afford any reason to suppose the previous occurrence of such an event since the origin of historical record;" so that we have no direct evidence that such an event has ever taken place, or that it ever will. We know too little of the physical constitution of the sun, and of the nature of comets, to be able to assert that the falling of a comet into the sun would actually recruit the luminous matter of which his outer surface is composed; for we have reason to believe that there is little or no analogy between the mode in which we supply our fires by means of fagots, and that by which the solar light is recruited and preserved in its pristine vigour; and besides, it is found that bodies, particularly in certain electric states, may be rendered luminous without the addition of any extraneous body to their substances.

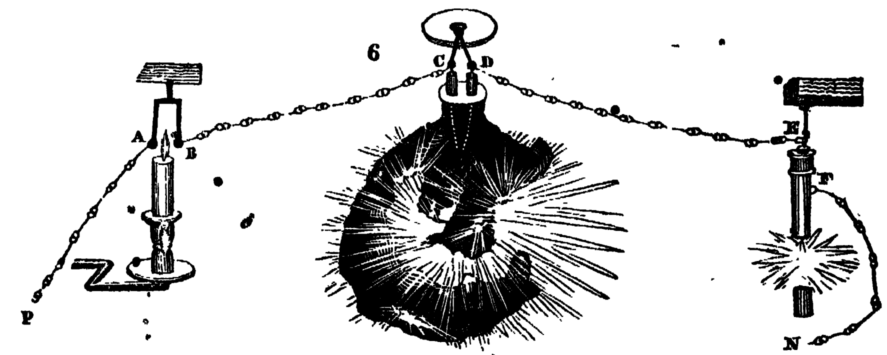
MISCELLANIES.

Use of Chloride of Lime in Removing the Smell of Fresh Paint.—In the room which is to be submitted to the action of the chloride, there are placed planks three feet in length by two in breadth. On these planks is spread some hay slightly moistened. The hay is sprinkled with chloride, and left for some days, taking care to keep the room closed. The decomposing action of the carbonic acid in the air, causes the chlorine to exude from the chloride of lime, which, being diffused in the room destroys the smell of paint. If the damp is required to be absorbed at the same time, pounded muriate of lime is placed on plates or in earthen vessels, pieces of chloride of lime or of muriate of lime pounded, which, having an affinity to moisture, attract the water from the atmosphere and becomes liquid. The same result may be attained by the use of chlorine. The operation is effected in the following manner:—A small earthen vessel is placed in the middle of the apartment; it is placed on a heated brick or on a small furnace, containing very little fire; in this vessel is afterwards put an ounce of oxide of manganese and three ounces of hydrochloric acid. The mixture must be stirred with a glass tube, and the windows and doors kept shut for twenty-four hours.—*Inventors' Advocate.*

New Railway.—We have seen a model of a railway on an entirely new construction, which does not require the use of locomotive engines. As the foreign patent is unsecured, we are not at liberty to explain the bearings and action, but we believe it will be found to be more simple and less expensive than the atmospheric railway, with all its advantages, and preferable to the rope used on the Blackwall Railway.—*Courier.*



ELECTRICITY.



ELECTRICITY.

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It is said by those who deny the materiality of the electric fluid, that it is only the agitation of the air which produces the effect, and that the compression of the air causes those igniting effects of the fluid, which we shall presently allude to. To confute this opinion by positive experiment may be difficult, yet an appeal to the reason will soon show the incorrectness of the opinion; look at the lightning and then say, can those mighty effects be occasioned by any compression of the air, which the mind can conceive, and even supposing that the air would be thus compressed, how immense must be the power which could thus compress it, and what is this power but the electric fluid; besides this, electrical appearances can be produced in a vacuum, the motion of the fluid, also, is inconceivably more rapid than the quickest motion of the air that we are acquainted with. We appear then warranted in assuming that the electric fluid is not air. Is it fire? Let us compare them. 1. Fire will inflame combustible substances, so will electricity.

Ex. 59.—*Canton's Phosphorus Illuminated.*—Take some of the powder of Canton's phosphorus, and by means of a little spirits of wine, stick it all over the inside of a clean glass phial, then stop the phial, and keep it from the light. To illuminate this phosphorus, draw several strong sparks from the conductor, keeping the phial about two or three inches from the sparks, so that it may be exposed to their light; the phial will afterwards appear luminous, and remain so for a considerable time.

Ex. 60.—Cut out in pasteboard, or soft wood, the figure of a crescent or any of the planets; cover this equally with the white of an egg, beat up till it is quite smooth, over which sift the phosphorus through a fine lawn sieve, then let it dry, and blow off all that is not fixed by the egg. To make the experiment, place the object in the communication between two directors, and discharge the jar, when the whole will become beautifully luminous; care must, however, be taken to hold the directors at a little distance above the phosphorus, for if it passes through it, the whole of the powder in the track of the fluid will be torn off.

Ex. 61.—Place a small key on the phosphorus, and discharge a Leyden phial over the phosphorus, and then throw the key off from it, and when it is exhibited in the dark, the form of the key and all its wards will be perfectly seen.

Ex. 62.—*Phosphorus Inflamed.*—Hold upon the point of a wire a small particle of phosphorus, and take a strong and sudden spark with it, the phosphorus will be inflamed; or stick a piece of phosphorus on a piece of sealing wax, and pass a shock from a Leyden jar through it, the phosphorus will burst into a flame.

Ex. 63.—Instead of the phosphorus in the last experiment, substitute a candle, the wick of which has just been blown out, and which has a long snuff; upon passing the shock, the candle will be relighted.

Ex. 64.—*To Fire Ether, or Spirits of Wine.*—Heat the cup, Fig. 1, then pour a small quantity of spirits of wine into it, and fix it by its handle to the end of the prime conductor; or fire the spirits, and blow them out a few minutes before the experiment is made; take a spark through the middle of the ladle with a brass ball, and the spirits will be fired by it.

Ex. 65.—Or, let a person standing on an insulated stool, and connected with the prime conductor, hold the cup with spirits in his hand, and let a person on the floor take a spark through them, and they will be fired. The experiment answers equally well, if the person on the floor holds the cup, and the insulated person takes the spark.

Ex. 66.—The foregoing experiment may be agreeably diversified in the following manner. Let one electrified person, standing on an insulated stool, hold the spirits; let another person, standing also on an insulated stool, hold in his hand an iron poker, one end of which is made red hot; he may then apply the hot end to the spirits, and even immerge it in them, without firing them; but, if he put one foot on the floor, he may set the spirits on fire with either end.

Ex. 67.—The spirits cannot be kindled by an insulated person; because, as the electric fluid cannot escape through him to the earth, he is incapable of drawing a spark sufficiently strong to inflame them.

Ex. 68.—Wrap round one of the balls of a discharging rod some tow, let it lie loosely, and when tied on dip and roll it in powdered rosin, discharge a Leyden jar with this discharger quickly, when the rosin will be inflamed.

It has been said that these, as well as some other experiments of a similar nature, may be explained, by supposing that the electric fluid, in its passage through the air, condenses it so much, as to occasion heat enough to inflame these combustibles; we shall endeavour to show that the air is scarcely condensed at all, and would not produce the effect if it were. If the air were condensed as the fluid passes from the positive to the negative side of the apparatus, it would be condensed at that point only, or if we suppose two electric fluids, rushing towards and meeting each other, the concussion, and consequently the condensation, could only take place at some point between the extreme end, neither of which appear to be the case; as, however, the experiments may be varied, there does not appear to be any reason to think that the inflammation takes place at any one point of the interrupted circuit rather than at any other point, besides which, when the inflammation of air and hydrogen gas takes place, the interruption of the circuit is extremely minute, and the air in a much less quantity, so as to diminish very much the probability of this assumption.

Ex. 69.—Make some hydrogen gas, by putting some nails, sulphuric acid and water, in a wine bottle, and catch the gas which rises in a bladder, furnish this with a pipe, a common pipe inserted in a cork will do, and after having procured some strong soap suds, blow some bladders. As these ascend, bring near to them a charged rod or conductor, when the bladders will be inflamed, producing a flash of light; as these bladders are very rapid in their ascent, so as often to baffle the operator, they may be inflamed before they are detached from the pipe by holding them near a charged conductor, being, of course, careful to cut off communication with the bladder, by turning the stop-cock between them.

Ex. 70.—*Hydrogen Pistol and Cannon*, represented in Figs. 2 and 3. These instruments are tubes of brass, having at one part of them in place of a touch-hole, a plug of glass or ivory, in the

middle of which runs a wire, with a ball on the outer part, and a point on the inner side, at a very short distance from the outer case, so that when a spark is given to the ball, it will pass down the wire, and from the end of it through the gas, to the tube without, in its passage through the small interruption inflaming the gas. The internal structure is seen in the dotted lines of the centre of Fig. 6; the lines withinside of the vases in Fig. 4; the dotted line of the cannon, Fig. 2; and still more explicitly in the pistol, Fig. 3, A represents this instrument and shows it in its complete state; B in its details, the brass tube being removed from one end, and the cap, or thimble, which defends the glass tube and ball from the other. In this figure, F is the ball which takes the spark; E E, the glass tube containing the wire G; D C, two screws by which the various parts of the instrument are fitted together.

Ex. 71.—*To Fill the Pistol.*—Apply the mouth of the pistol to the opening of the bottle, and the common and inflammable air will mix together, because the former being heavier than the latter will naturally descend; keep the pistol in this situation about fifteen seconds, then remove it, and cork the pistol. If the pistol is held too long over the bottle, and is entirely filled with inflammable air, it will not explode, to remedy this, blow strongly into the muzzle of the pistol; this will force out a quantity of the inflammable air, and occasion a quantity of common air to enter the pistol, which will then readily explode.

Ex. 72.—*To Fire Inflammable Air.*—Bring the ball of the pistol which is charged with inflammable air near the prime conductor, or the knob of a charged jar; the spark which passes between the end of the wire G, and the piece D, Fig 6, will fire the inflammable air, and drive the cork to a considerable distance. This air, like all others, requires the presence either of common air, or else of vital air, to enable it to burn; but, if it is mixed with a certain quantity of common air, an explosion will take place in passing the electric spark through it.

Mr. Cavallo recommends a pistol made in the following manner, to those who wish to make experiments on the explosion of hydrogen and oxygen, or with known quantities of common air and hydrogen. It consists of a brass tube, about one inch in diameter and six inches long, to one extremity of which a perforated piece of wood is securely fitted; a brass wire, about four inches long, is covered, except its ends, first with sealing wax, then with silk, and afterwards with sealing wax again. This wire is to be cemented in the perforation of the wooden piece, so as to project about two inches within the tube, the rest is on the outside; that part of the wire which is within is bent, so as to be only about the tenth of an inch from the inside of the brass tube.

An instrument such as this forms part of the apparatus, Fig. 6.

Ex. 73.—*The Magic Vases.*—This amusing piece of apparatus is seen in No. 4. The structure is evidently upon the principle of the electrical pistol. The two vases have each a hollow brass chamber at top, part of the side of which is cut away in the figures to show the wire withinside. The wire is continued downwards through the entire stem, and connected with the chain at the bottom. To use the vases, load them in the same way as the pistol was loaded, with hydrogen gas, and cork them up; after which, connect the tops together by a chain, as represented; also let the chain P be attached to the discharging rod, and the chain N to the outside of a charged jar, upon making the discharge. The fluid will pass up the stem of the vase connected with P, pass out at the end of the wire, across to the side of the chamber, setting fire to the gas within and throwing out the cork. It thence proceeds by the chain to the outer case of the other chamber to the point of its wire, inflaming the gas in the other vase, and downwards out at the foot along the chain N.

If the chain at top be changed to a wire a mile in length, so that the fluid may pass the whole of that distance, yet the rapidity of its motion is such, that the two chambers of gas will explode so simultaneously, as to be heard but as one report. A variety of this experiment, and which occasions considerable amusement, is made by asking a person to hold the vases one in each hand; when the shock is passed he will of course feel it, as it will pass through his arms, and being accompanied with a loud report, it will, though trifling in itself, mostly occasion considerable alarm to the person receiving the shock. and equal amusement to the bye-standers who know that his alarm is groundless.

Ex. 74.—*Firing Gunpowder and Powder House.*—The firing of gunpowder by electricity has been already fully explained in No. XIX. Vol. 1. The subject is here alluded to to show the close analogy between electricity and heat, and to point out the apparatus called a powder house, and which is represented in Fig. 5. The house itself is supposed to have one side removed to show its internal structure. It is made of seven pieces of wood, so united together by hinges, that when the powder withinside is inflamed, the whole of the sides will fall down flat with the table. A represents an ivory cup filled with very dry gunpowder, having a wire through each side, and nearly meeting in the middle, a shock is passed from P through a piece of *wetted thread* B (this is absolutely necessary) then through the powder, and out again to the chain N.

Ex. 75.—*The Chain Illuminated.*—Form an iron chain by cutting wire into lengths about two inches each, and turning up the ends, link one piece to another; hang this around a room by silk strings, and pass a shock along it, when it will appear beautifully luminous at every link of the chain, appearing like a continued line of the most brilliant star-like sparks.

Ex. 76.—*Firing a Bladder of Gas.*—Fig. 7 shows an arrangement for this purpose, together with some other experiments we have above alluded to, P is where the fluid enters; it passes to A as this is hung upon silk, or supported by a glass rod, the fluid cannot pass round the elbow at the top to B, but will strike through the candle; if the wick of the candle has been previously soaked in ether, it will be lighted. The fluid then passes along to D, down the wire, in the glass tube, into the bladder, across the points of the wires withinside (inflaming the gas), and up the other tube to D, along the second wire to E, down the pistol, which is made precisely like one of the magic vases to the outer tube F, and thence to the outside of the bottle. A pint bottle charged is quite enough for any of the above experiments, and the gas may be inflamed by the smallest possible spark. Space will not allow other illustrations in the present paper, but the subject would be very incomplete did we not briefly allude to some other analogies between electricity and heat; it will be remarked then,

2. Heat is produced by friction, so is electricity.

3. The best conductors of heat are also mostly the best conductors of electricity.

4. Metals are melted by heat, and also by electricity.

Notwithstanding this strong analogy between heat of fire and the electric fluid; yet there are some circumstances adducible, which appear to contradict our position, and as all who are desirous of knowledge, ought to consider both sides of the question, it becomes us not to neglect them; therefore it must be observed—

1st. The electric fluid has a strong scent which simple heat has not.

2nd. An increase of heat produces an increase of fluidity; bodies charged positively are not thereby rendered fluid; so 3rd, a deprivation of the electric matter which a substance may contain, does not cause the same congelation as that occasioned by abstracting caloric from it.

4th. Caloric not only heats, but expands bodies; the electric fluid does not produce these effects. However long a substance may be electrified it neither becomes hotter to the touch, nor more extended in dimensions.

5th. Nothing at all analogous to the nature of electrical attraction and repulsion can be discovered in heat.

PHOTOGENIC DYEING.

BY M. LAPOURAILLE.

A DYER, at Lyons, has for some years past been endeavouring to bring to perfection a mode of dyeing silks and cotton by solutions of metals alone, without the addition of any coloring matter. He found the solution of gold to be the best adapted for this purpose, and though he by this means contrived to produce a beautiful lilac and violet tint on the silks, they were not durable, and the expenses of such a mordant as a solution of gold induced him to discontinue his experiments. The plan he pursued was that of producing or deepening the tints to be obtained by exposure to the light, therefore it may be properly called a photogenic process. Though M. Lapouraille did not succeed to such an extent as he desired, he still conceives the plan capable of being carried into effect with great advantage; and for the purpose of directing attention to the process, and of assisting others who may wish to pursue the experiments, he has given the following account of those he instituted, with the results:—

"In one-third part of hydrochloric acid and two of nitric acid, I dissolve fine gold. I pour some distilled water into a vessel. I add to it a few drops of the solution of gold, and then put in my silks. Whether the silk be dressed or undressed, the effect is always produced: but the color is more beautiful in white silk that has been dressed. After the silk has remained ten minutes in the diluted solution of gold, I squeeze it, and put it to dry without washing. The color that the silk has taken is a bright straw color; no change is perceptible on the first day; and, in the shade, not any on the second; but when exposed to the sun, the silk assumes various colors, alternating from red to yellow and lilac; and by this variation of color forming changes of tints that disappear when removed from the sun. Unfortunately, these tints are neither beautiful nor permanent beyond ten or twelve days at most. After this time the grey lilac, almost white, color that the silk assumes in the shade has only a slightly redder tinge when exposed to the sun, but the varying tints are lost. In order to obtain lilac as well as violet color, the acid must be extracted from the silks that have gone through the solution of gold. They are then exposed to the sun, and in a shorter or longer time, according to the power of the sun, a very fine lilac is obtained; in summer one hour is long enough, but in winter it requires eight days, fifteen days, and sometimes even a month. In a camera obscura I have obtained very pretty tinges of lilac in ten minutes. To procure tints as deep as violet, it is requisite to put the silk already tinged with lilac again into the diluted solution of gold; the color is not destroyed—it is rendered more bright. It is dried without being washed, the acid is afterwards extracted, and it is exposed to the sun; in a few hours the tint becomes twice as strong, and by repeating this process five or six times a beautiful violet color is obtained.

"On paper and on cotton, lilacs are obtained in the same manner, but the color is not so deep as it is upon silk. I have kept silks for three years dipped in a solution of gold. They had only a slight tinge of grey lilac, almost white, but after extracting the mordant and drying the silks in the sun, I have produced a very fine lilac twenty times deeper than it was before. All the lilac or violet colors which are obtained by the solution of gold, become red when exposed to the sun, to artificial light, or to a solution of alkalies; in the shade, or in contact with acids, they become blue; in the air they are unchangeable.—*Inventors' Advocate.*

GUM.

GUM is a transparent and slightly-yellowish substance, having a conchoidal fracture when concrete, and limpid and colorless when dissolved; it is soluble in cold water, and still more so in boiling water; it does not acquire a blue or purple color by the action of iodine; it is insoluble in alcohol, ether, the acids, and the alkalis, and consequently its solution is coagulated by them and all the inorganic substances that attract water strongly; it is converted into sugar by the action of sulphuric acid, and into malic, oxalic, and often also mucic acid by the action of nitric acid; in fine, it is not fermentable even with the addition of either sugar or gluten.

Gum is found in larger or smaller masses convex on the outside and generally concave and hollow within, on certain shrubs whose sap vessels superabound in this product, which accordingly concretes on the surface of the bark through which it makes its way by raising it up and tearing it; and it is detected by analysis in vegetables wherever there is an organ to be developed.

Since gum circulates in the sap, it must be evident that when it concretes around the fissures of bark it will envelope in its substance the debris of the textures which it has distended and torn, as well as the numerous salts which circulated along with it in the sap vessels. Hence it is also evident that when it is treated by reagents it may present accessory characters, varying according to the presence or the absence, the nature, the quantity, and the different combinations of all these different foreign substances. If these characters were considered as specific, we must suppose almost as many species of gum as there are vegetables submitted to analysis. Chemists have found this method easier than to

undergo the labor of inquiring into the causes that produced these accidental differences.

Gum is, so to speak, the plastic substance of the textures. Now, as the textures, before they finally attain the consistence which characterizes them, must pass from the primitive state of perfect fluidity through all the gradations of a *tendency to organise*, we must expect not only to find some gums more soluble than others, but also to find in the same gums very great differences of solubility, and even more or less considerable fragments of completely-formed textures.

These general considerations are applicable not only to the effects of reagents, but also to the elementary analysis of the gums.

In employing the word *Species*, then, to designate the gums which are obtained from different vegetables, it is only meant to express a peculiar assemblage of characters which are foreign to the substance itself.

FIRST SPECIES.

Gum of Starch.—The gum of starch is the soluble substance of fecula deprived of the property of being colored blue by iodine, either by roasting or by prolonged exposure to the air.

The soluble substance of fecula may be regarded as gum in the purest state. Roasting and spontaneous decomposition, while they deprive it of the property of being colored by iodine, seem to modify its constitution slightly. Accordingly diluted sulphuric acid does not change the gum of roasted fecula in sugar; and the subacetate of lead and the infusion of galls do not precipitate the gum of spontaneously-decomposed starch, although solution of barytes slightly troubles it. But roasting would communicate the former of these negative characters to pounded gum arabic; and as to the latter we must not forget that, during the spontaneous decomposition of starch, there is a production of sugar and often of ammonia more or less combined, substances which it is very difficult to separate entirely from the gummy matter.

Nitric acid does not change it into mucic acid. This circumstance constitutes the principal difference between it and gum arabic.

SECOND SPECIES.

Gum Arabic and Senegal.—This gum exudes from the Acacia Vera, the Acacia Arabica, and the Acacia Senegal. It is in rounded mammellated masses, hollow within, transparent and slightly yellowish.

It is slowly dissolved in cold water, becoming at first ropy; and, when the solution is completed, a residue of impurities is found at the bottom of the vessel, which may be diffused through the liquid by agitation, rendering it less transparent, after which it does not completely recover its limpidity unless by filtration or by clarifying, by which these debris are removed, or by exposing it for a short time to a temperature not far removed from 32°, and carefully decanting.

When subjected to dry distillation it yields ammonia, and yet its solution is not alkaline; the ammonia must therefore be in it in the state of salt. By incineration it yields 3. of ashes in 100. and these ashes are formed of *carbonate of lime* and a small quantity of *phosphate of lime* and of *iron*. Now, as gum does not effervesce with acids, the lime cannot be in this state of combination in it. Vauquelin supposes that it is in the state of acetate or malate. It is not combined with the texture, for oxalic acid precipitates it from the solution of gum, as does also sulphuric acid. This latter precipitate assumes the form of small needles of sulphate of lime visible by the microscope.

All these circumstances lead to the supposition that there may exist in gum arabic different species of saline combinations susceptible of being destroyed or modified by incineration. It would, then, be very illogical to attribute to the intrinsic nature of the gum, rather than to the presence of these mixtures, the different precipitates which it is capable of producing with various reagents. It might be objected to this principle, that gum precipitated by oxide of lead leaves no ashes on incineration; but this objection disappears when we recollect that gum contains indeterminate vegetable acids, which would be decomposed by incineration, on the supposition that the oxide of lead had separated them from the bases with which they were combined. These principles being once laid down, I proceed to say that gum arabic is coagulated as the soluble substance of fecula is, by borax, and by potash, and that this coagulum, if it has not been too long exposed to heat, is re-dissolved by acids and by supertartrate of potash; that the sulphate of iron precipitates it in the form of an orange coagulum, which is insoluble in cold water, but soluble in cold water, but soluble in acetic acid or in potash; that the chloride of iron precipitates it in a brown gelatinous mass; and, finally, that it is precipitated by nitrate of mercury and silicate of potash.

It remains for the new method of investigation to ascertain the true origin of all these re-actions. With respect to the common theory, according to which these different precipitates are viewed as atomic combinations of gum with bases or acids, may form a subject of future consideration.

Prout found that gum, as well as fecula and woody matter, might be represented by a combination of one atom of water, provided it had been previously perfectly dried. The elementary analysis of Gay-Lussac, Berzelius, and Saussure, agree pretty nearly with this statement, except that Saussure found in it a portion of nitrogen of which the other chemists did not perceive the smallest traces. Here, however, a difficulty occurs, and which, in this case, operates in favor of Saussure's analysis. Gum, by distillation, gives ammoniacal products, yet its elementary analysis indicates no nitrogen. We must necessarily conclude that our methods of analysis disjoined from theoretical considerations are not sufficient to meet the demands of science. It is not, however, the less necessary, on this account, to compare the results obtained by the authors mentioned.

Elementary Composition of Gum Arabic.

	Carbon	Oxy.	Hydro.	Nitro.
Gay-Lussac and Thenard,	42.23	50.84	6.93	
Berzelius, ...	42.68	50.95	6.37	
Saussure..............	45.84	48.26	5.46	0.44

(To be continued.)

MANUFACTURE OF PENCILS.

The word pencil is used in two senses. It signifies either a small hair brush employed by painters in oil and water colors, or a slender cylinder of black lead or plumbago, either naked or inclosed in a wooden case, for drawing black lines upon paper. The last sort, which is the one to be considered here, corresponds nearly to the French term crayon, though this includes also pencils made of differently colored earthy compositions.

The best black-lead pencils of this country are formed of slender parallelopipeds, cut out by a saw from sound pieces of plumbago, which have been previously calcined in close vessels at a bright red heat. These parallelopipeds are generally inclosed in cases made of cedar wood, though of late years they are also used alone, in peculiar pencil-cases, under the name of ever-pointed pencils, provided with an iron wire and screw, to protrude a minute portion of the plumbago beyond the tubular metallic case, in proportion as it is wanted.

In the year 1795, M. Conté, a French gentleman, well acquainted with the mechanical arts, invented an ingenious process for making artificial black-lead pencils of superior quality, by which he and his successor and son-in-law, M. Humblot, have realised large fortunes.

Pure clay, or pipe-clay containing the smallest proportion of calcareous or siliceous matter, is the substance which he employed to give aggregation and solidity, not only to plumbago dust, but to all sorts of colored powders. That earth has the property of diminishing in bulk, and increasing in hardness, in exact proportion to the degree of heat it is exposed to, and hence may be made to give every degree of solidity to crayons. The clay is prepared by diffusing it in large tubs through clear river water, and letting the thin mixture settle for two minutes. The supernatant milky liquor is drawn off by a syphon from near the surface, so that only the finest particles of clay are transferred into the second tub, upon a lower level. The sediment which falls very slowly in this tub, is extremely soft and plastic. The clear water being run off, the deposit is placed upon a linen filter, and allowed to dry. It is now ready for use.

The plumbago must be reduced to a fine powder in an iron mortar, then put into a crucible, and calcined at a heat approaching to whiteness. The action of the fire gives it a brilliancy and softness which it would not otherwise possess, and prevents it from being affected by the clay, which it is apt to be in its natural state. The less clay is mixed with the plumbago, and the less the mixture is calcined, the softer are the pencils made of it; the more clay is used the harder are the pencils. Some of the best pencils made by M. Conté, were formed of two parts of plumbago and three parts of clay; others of equal parts. This composition admits of indefinite variations, both as to the shade and hardness; advantages not possessed by the native mineral. While the traces may be made as black as those of pure plumbago, they have not that glistening aspect which often impairs the beauty of black-lead drawings. The same lustre may, however, be obtained by increasing the proportion of powdered plumbago relatively to the clay.

The materials having been carefully sifted, a little of the clay is to be mixed with the plumbago, and the mixture is to be triturated with water into a perfectly uniform paste. A portion of this paste may be tested by calcination. If on cutting the indurated mass, particles of plumbago appear, the whole mass must be further levigated. The remainder of the clay is now to be introduced, and the paste is to be ground with a muller upon a porphyry slab, till it be quite homogeneous, and of the consistence of thin dough. It is now to be made into a ball, put upon a support, and placed under a bell glass inverted in a basin of water, so as to be exposed merely to the moist air.

Small grooves are to be made in a smooth board, similar to the pencil parallelopipeds, but a little longer and wider, to allow for the contraction of volume. The wood must be boiled in grease, to prevent the paste from sticking to it. The above described paste being pressed with a spatula into these grooves, another board, also boiled in grease, is to be laid over them very closely, and secured by means of screw-clamps. As the atmospheric air can get access only to the ends of the grooves, the ends of the pencil-pieces become dry first, and by their contraction in volume get loose in the grooves, allowing the air to insinuate further, and to dry the remainder of the paste in succession. When the whole piece is dried it becomes loose, and might be turned out of the grooves. But before this is done, the mould must be put into an oven moderately heated, in order to render the pencil pieces still drier. The mould should now be taken out, and emptied upon a table covered with cloth. The greater part of the pieces will be entire, and only a few will have been broken, if the above precautions have been duly observed. They are all, however, perfectly straight, which is a matter of the first importance.

In order to give solidity to these pencils, they must be set upright in a crucible till it is filled with them, and then surrounded with charcoal powder, fine sand, or sifted wood ashes. The crucible, after having a luted cover applied, is to be put into a furnace, and exposed to a certain degree of heat regulated by the pyrometer of Wedgewood; which degree is proportional to the intended hardness of the pencils. When they have been thus baked, the crucible is to be removed from the fire, and allowed to cool with the pencils in it.

Should the pencils be intended for drawing architectural plans, or for very fine lines, they must be immersed in melted wax, or suet nearly boiling hot, before they are put into the cedar cases. This immersion is best done by heating the pencils first upon a gridiron, and then plunging them into the melted wax or tallow. They acquire by this means a certain degree of softness, are less apt to be abraded by use, and preserve their points much better.

When these pencils are intended to draw ornamental subjects with much shading, they should not be dipped as above.

Second process for making artificial pencils, somewhat different from the preceding.—All the operations are the same, except that some lamp-black is introduced along with the plumbago powder and the clay. In calcining these pencils in the crucible, the contact of air must be carefully excluded, to prevent the lamp-black from being burned away on the surface An indefinite variety of pencils, of every possible black tint, may thus be produced, admirably adapted to draw from nature.

Another ingenious form of mould is the following: Models of the pencil-pieces must be made in iron, and stuck upright upon an iron tray, having edges raised as high as the intended length of the pencils. A metallic alloy is made of tin, lead, bismuth, and antimony, which melts at a moderate heat. This is poured into the sheet-iron tray, and after it is cooled and concreted, it is inverted and shaken off from the model bars, so as to form a mass of metal perforated throughout with tubular cavities, corresponding to the intended pencil-pieces. The paste is introduced by pressure into these cavities, and set aside to dry slowly. When nearly dry, the

pieces get so much shrunk that they may be readily turned out of the moulds upon a cloth table. They are then to be completely desiccated in the shade, afterwards in a stove-room, next in the oven, and lastly ignited in the crucible, with the precautions above described.

M. Conté recommends the hardest pencils of the architect to be made of lead melted with some antimony and a little quicksilver.

In their further researches upon this subject, M. Conté and M. Humblot found that the different degrees of hardness of crayons could not be obtained in an uniform manner by the mere mixture of plumbago and clay in determinate doses. But they discovered a remedy for this defect in the use of saline solutions, more or less concentrated, into which they plunged the pencils, in order to modify their hardness, and increase the uniformity of their texture. The non-deliquescent sulphates were preferred for this purpose; such as sulphate of soda, &c. Even syrup was found useful in this way.

MANAGEMENT OF THE OXY-HYDROGEN MICROSCOPE.

(Resumed from page 315.)

To put in action this instrument it, of course, is first necessary to procure the requisite gases, oxygen and hydrogen; oxygen we have given a full account of making in No. XXXVII., Vol. I., and also hydrogen, in No. LIII., Vol. II., to dwell upon this part then would be superfluous, except to remark that the coal gas used in the streets and houses is quite as good, and in the opinion of most persons, better than that made by the mixture of iron, sulphuric acid and water; also, any convenient bag may be employed to hold them, provided that such bag have a weight put upon it to produce the requisite pressure, which pressure is about 50 pounds to each bag. In making either gas, observe carefully to empty the bag completely of atmospheric air, before they are connected with the gas apparatus, if this is not attended to, an explosion will probably be the consequence; not, indeed, with the oxygen, though this being diluted with atmospheric air becomes less serviceable, because less pure; the hydrogen being mixed with atmospheric air, becomes an explosive mixture, highly dangerous to use. The same remark will be a caution to young experimentalists, not to mix the two gases together in the same bag, previous to using them, for fear of danger, the two gases forming a much more explosive mixture, than if atmospheric air were one part of the mixture. The gases being made, and the gasholders attached to the orifices prepared for them, take care, by means of a leather washer, to make the joints perfectly tight. To ascertain this, light a match or piece of stick, let it burn for a few seconds till the substance becomes ignited to redness, then blow out the flame, and pass it closely around each junction of the parts of apparatus connected with the oxygen gas bag and its flexible pipe. If there be any escape of that gas at any joint, the charcoal will glow with increased brilliancy. If this should occur, shut the stop-cock at the mouth of the bag, and search for the cause. This will, probably, be found to be an imperfect leather washer, or negligence in screwing home the union-joint. The joints of the hydrogen gas bag and flexible gas tube are to be tested with a lighted match or taper, so as to inflame the gas that may issue at any leakage. If such flames appear quench them immediately, by blowing out or smothering them ere they injure the substance of the bag or tube, and then shut off the pressure, look to the washers, and the state of the union-joints, as before directed; on no account proceed to light the gases till you have satisfactorily proved the perfection of the union-joints through which they pass; otherwise, you not only expose them to waste, but are further liable to fail in the production of an efficient light by an unseen waste of materials, and consequently to failure and disappointment in your exhibitions and experiments.

To Light the Gases.—Having effectually guarded against further leakage by ascertaining the completeness of all the union-joints, the next step is to complete the blow-pipe arrangement by putting a lime-cylinder on the lime-holder, for which purpose there is a central perforation left in the cylinder, into which the spindle fits. The height of the top of the spindle can be accurately adjusted to that of the nozzle by a sliding vertical motion through the spring-cylinder which holds it firmly, yet freely, so as to permit its elevation or depression at pleasure. Then partially open the hydrogen cock and inflame the gas as it issues from the blow-pipe. This flame will play against the lime-cylinder and heat it gently, preparatory to the more intense action it is to undergo, but it must be managed with great care and some judgment at first, so as barely to allow it to cover the near side of the cylinder with a bright reddish glow, but not to allow it to impinge on it violently; otherwise it would be reflected against the interior condensing lens, and certainly crack it by the sudden access of heat and irregular expansion that would ensue. When the jet of hydrogen flame is regulated to a good heating effect, turn the lime-holder slowly round and round by means of the milled head which terminates its lower end beneath the base. You will thus heat the lime-cylinder gradually and safely, thereby quietly expelling all the moisture it may have imbibed from the atmosphere; whereas, were you to heat it rapidly, the moisture would be converted into steam so suddenly that the lime-cylinder would probably crack, split, and fly in fragments. During this operation you will observe a curious phosphorescent appearance playing round the flame where it is in contact with the glowing cylinder. When you have perfectly dried the lime by the action of the hydrogen jet alone, you may introduce the oxygen gas into the centre of the flame by gently opening the stop-cock. Should you do this suddenly you will extinguish the flame altogether. When the oxygen is skilfully and patiently admitted, the compound flame will produce a brilliant glow on the lime-cylinder altogether different from, and vastly superior to, the best effect produced by the hydrogen jet. You may now attain the highest intensity of light by holding the oxygen and hydrogen stop-cocks one in each hand, adjusting nicely the influx of both gases, and watching the effect on the lime-cylinder (through the colored eyeglass in the side of the lantern, if the naked light be too powerful for your eye) until by gradually increasing or diminishing the supply of each, you arrive experimentally at the proper proportions of both. An excess of hydrogen will be indicated by the appearance of a reddish flame surrounding, and of course

obscuring, the glow of white light that radiates from the cylinder. Additional oxygen will remove the redness, but an excess of this gas will diminish the white light, and if the proportion be increased will at last extinguish it altogether. Attention must also be paid to the position of the blowpipe nozzle so as to attain the most favorable distance and direction for playing upon the lime. This can easily be ascertained and regulated by means of the universal joint. You must recollect during these trials, that the lime-cylinder is a substance possessed of very slight cohesion; and that it is liable to be rapidly volatilized or carried off by the action of the blowpipe wherever any one portion of the surface is continuously exposed to the intense heat generated at the apex of the flame. To prevent this, you must turn the lime-holder every three or four minutes by the milled head at the bottom of the spindle so as to expose a new surface to the action of the hydro-oxygen jet. This is a troublesome duty, but it must be carefully executed, otherwise the surface of the lime-cylinder would be worn into a hole, the concavity of which would throw back the inflamed gases against the interior condensing lens, and thereby most probably crack it into a thousand pieces.

To adjust the Light and Lenses.—The next point in the management of the lantern is to obtain a uniform disc of light, on the whitewashed wall, or on a white linen or calico screen hung perpendicularly against it for the purpose. When you find that the lime-cylinder is giving out an intense steady light, place the low magnifying power on the end of the tube, shut the door of the lantern, and exclude every light from the room, except what passes through the microscope to the wall. When you turn your eyes towards the disc produced there, you will perhaps be much disappointed at beholding its centre only lit up, and darkness radiating towards the circumference, or *vice versâ;* the centre very dull, and a scattered illumination towards the edge of the circle. These defects are, however, easily removed: both are occasioned merely by the want of adjustment of the focal distance between the lime light and the first condensing lens; and both may be obviated by sliding the body of the lantern which carries the lens (while the light stands fast) to and fro in the groove at the top of the base board, until the proper focal position be attained, when the disc of light will be uniform throughout.

We are obliged to defer the consideration of objects and screens till our next.

CHEMICAL TESTS.

(*Resumed from page* 295.)

Test for Silver.—Dissolve an ounce of nitrate of potass in eight ounces of sulphuric acid, in a glass vessel over a lamp, and put into it several pieces of impure silver, or suspected coin. When the liquid arrives at the temperature of 220°, the silver will be acted on by (what may be termed) the nitro-sulphuric acid: this action will be attended by an evolution of nitrous gas. The best property of this solvent, is, that it does not act on any other metal than the silver: consequently if base silver coin be held with a forceps in this hot acid, it will be quickly stripped of its silvery coat, and the copper, &c. will be exposed to view. This compound acid is also useful in the large way, in extracting pure silver from old plated goods, as the copper, &c. cannot be acted on.

Tests for Gums in Solution.—Pour into a solution of gum, a solution of acetate of lead; a very flocculent precipitate will fall down, composed of gum and oxide of lead. Here the acetic acid quits the lead to combine with the water, consequently the oxide falls down with the gum.

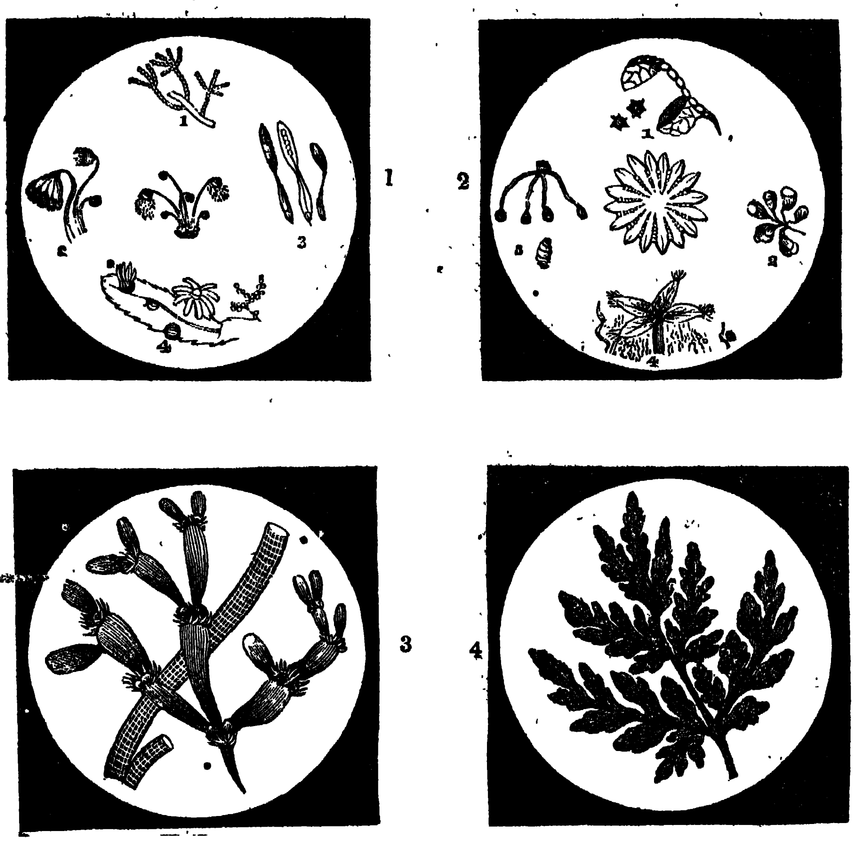
Tests for the presence of Titanium.—Pour a little of the muriate of titanium into three wine glasses: into one pour a solution of carbonate of potass, a *white* precipitate will fall down. Immerse a piece of zinc in the other glass; a *blue* color will be produced. If a tin rod is immersed in the third glass, the color will change to a beautiful *red.*

Tests of the Purity of Nitric Acid.—In manufacturing nitric acid in the large way, it is often adulterated by muriatic and sulphuric acids. To separate from it the latter of these substances, pour in a solution of nitrate of barytes, as long as a precipitate of sulphate of barytes falls down. Now pour off the acid into another vessel, and add to it a solution of nitrate of lead, made with boiling water; a precipitate of muriate of lead will accordingly fall down. When this has settled, pour off the clear liquid into a retort and distil to expel the water which was necessarily combined with the precipitants, for their solution. To preserve this acid from decomposition, it should, if in a clear glass bottle, be kept in a dark place.

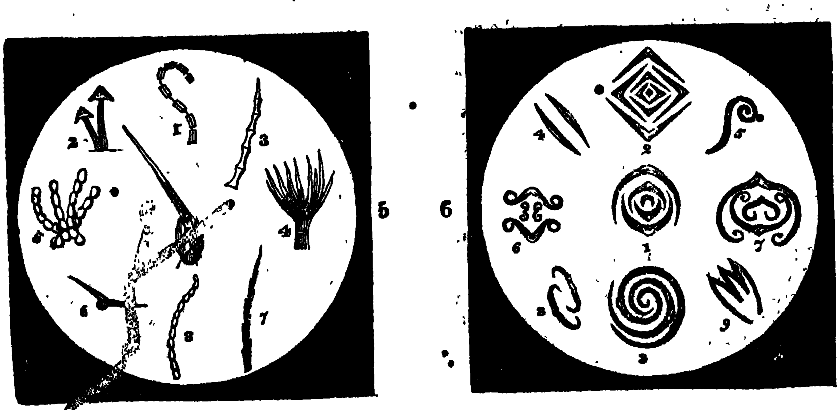
Test of the Purity of Chloric Acid.—Pour some chloric acid, (obtained from chlorate of barytes and sulphuric acid) into two wine glasses. Into one of these pour some diluted sulphuric acid, if a white precipitate falls down, it is a proof of its being adulterated by barytes; this precipitate being sulphate of barytes. To the other glass add a solution of chlorate of barytes, if a white precipitate should here fall down, it is a proof that an excess of sulphuric acid has been added in the formation of the chloric acid; consequently, the latter is far from being pure. The white precipitate afforded by the latter test, is also sulphate of barytes.

Proof of the existence of Carbonic Acid Gas in the Atmosphere.—Take a pencil of pure potass from the phial in which it is kept, and place it on a saucer in the open air. In a very short time, it will swell, and at the extremities will branch out like a cauliflower. Leave it undisturbed until it crumbles and falls to powder; if the atmosphere be moist, the moisture as well as the carbonic acid will be attracted. Now collect the potass, and put into a small tubulated retort: pour over it three or four drams of diluted sulphuric acid; effervescence will be the consequence, and a gas will come over which may be received in a jar over mercury or water. This gas is carbonic acid, imbibed by the potass from the atmosphere. The certainty of its being so, was proved by the effervescence which took place upon adding the sulphuric acid; it may be further proved by its inability to support combustion or animal life; also by reddening wet litmus paper immersed in it; and likewise by rendering lime water turbid, when agitated with it. That no carbonic acid existed previously in the potass, may be proved, by pouring an acid over it in its pure state.

(*To be continued.*)



OBJECTS FOR THE OXY-HYDROGEN MICROSCOPE.



OBJECTS FOR THE OXY-HYDROGEN MICROSCOPE.

(*Resumed from page* 328.)

The screen to be used with the oxy-hydrogen microscope may be made and put up exactly in the same manner as that for the magic lanthorn, and of which we gave a full account in Vol. I. It is only requisite, therefore, to state, that a white-washed wall, or a sheet, stretched tightly over one side of an apartment, will answer extremely well for private exhibition, as well indeed as the best prepared screen.

The objects adapted to exhibition by this instrument are extremely numerous, comprising subjects in all the more delicate departments of natural history, both vegetable and animal; and, although the gas microscope is not adapted to show opaque objects, and scarcely exhibits those exquisitely fine and delicate tests, which show the perfection of the best constructed table instruments; yet owing to its larger fields of view, and larger object glasses, it is able to take in very numerous subjects, which, from their large size, cannot be seen by the table microscope, but by minute portions at a time.

Objects for the gas microscope are usually fixed upon pieces of glass, and contained in a mahogany frame; and the instrument will usually, with the lowest power, take in objects of an inch in diameter; therefore the wings of moths, sections of woods, &c., may be seen whole, and it is evident that if small insects are to be exhibited several may be placed upon one slider.

We shall first consider vegetable objects, or such of them as are at the same time beautiful and illustrative. To say which of them is most handsome is difficult, so full of perfection are the works of nature; but it is in the minuter departments of it, that the microscope is adapted to show. We shall begin with some of the fungi, or *mould*, which are considered as the lowest order of creation, arising from damp, and nourished by decay; we are apt to consider such minute objects as unworthy our notice, yet some of them are of exquisite structure. The first circle exhibits numerous of them; that in the centre is the mould upon bread. It is seen to consist of numerous fine threads, each bearing a ball upon its summit, one of them scattering its seed, although the whole plant is almost too small for the unassisted sight.

Fig. 1 is the aspergillus penicillatus, or the pencilled mould. Its stem and branches resemble strings of beads, united into necklaces. It is extremely common in collections of dried plants, when they have been neglected, and attracted mouldiness.

Fig. 2 exhibits a somewhat rare plant, called dictydium cernuum: it is found on rotten wood. When young it much resembles mould, but as it increases in age it opens with the most beautiful rays.

Fig. 3 shows a magnified representation of a part of one of the minute brown spots, which are often found under the leaves of the rose tree. It is called puccinia rosæ; one of the specimens shown is supposed to be in a young state. In the middle one is seen the seeds, and that nearest to the centre is one which is ripe, but which has not yet scattered its seeds. The lowest figure represents a most beautiful and minute plant of this kind, growing upon the leaf of a moss; and by the side of it is a portion taken from the inside, and shows the seeds, together with the thread-like fibre to which the seeds are attached. The plant is called diderma, it is somewhat rare.

To proceed further with the fungi would be unadvisable, but the whole class affords subject for much entertainment and instruction; and the subjects are inexhaustible. England alone producing nearly 2000 different species of fungus, all of singular, yet simple structure.

The other tribes of flowerless plants are even more worthy of our attention than the fungi, as displaying the wonders of the minutest parts of creation. Without at the present time describing the various forms and singular structure of their leaves, we may offer a remark or two upon the seeds and seed vessels, some of which are depicted in diagram No. 2. The object in the centre is the mouth of one of the seed vessels of a moss; at first all the teeth represented, and which are always either 4, 8, 16, 32, or 64, are folded inwards covering up the mouth; afterwards those last forming the outer row are bent backwards and resemble a fringe around the mouth of the capsule or seed vessel. The teeth in some species are twisted together, in others jointed, and in all endowed with the most regular and beautiful form and the most vivid colors. Mosses are now in their greatest perfection, and some kinds or other are to be found on every wall and bank of earth. It is not merely the mouth of the capsule which is worthy of attention, but the cellular structure of the leaves and other parts. Near akin to the mosses are the jungermanniæ; the seed vessel of one of them is seen splitting up and scattering its seeds in Fig. 4 of the same diagram. This seed vessel breaks into four pieces, and the seeds are, moreover, attended with fine elastic screw-like filaments, which, untwisting suddenly when the seed-vessel opens, scatters the seed to a considerable distance. The leaves of this tribe are of wonderful beauty, variety, and delicacy; the plants may be found growing abundantly on trees and the ground, particularly in the north of the kingdom, though some kinds are sufficiently abundant in the south. The equisetums, or horse-tails, are well-known plants; cross sections of the stem are extremely beautiful as microscopic objects; the seed is still more so, this part is seen in Fig. 3; the seeds are so minute as to be invisible to the naked eye, but when magnified present a curious formation. The seed while in the seed-vessel is coiled round by four filaments, club-shaped at the end; when the seed has dropped, the filaments uncoil themselves supporting the seed as represented. At every change of weather the filaments contract or dilute, and, in consequence, the seed is moved forwards, and appears in constant agitation.

Figures 1 and 2 show the seed-vessels of another tribe of flowerless plants—the ferns. These seed-vessels are borne upon the plants in bunches, called sori. They are at first round, afterwards become pear-shaped, and then appear furnished with an elastic ring on one side. When ripe the elasticity of the ring is such as to overcome the cohesion of the sides of the seed-vessel, when it snaps asunder, and, jerking to and fro in a very curious manner, scatters the seed to a considerable distance. The leaves and stems of the ferns are no less beautiful and worthy of attention. Diagram No. 4 shows the top of one of their leaves as capable of being exhibited by the microscopic lanthorn.

Diagram 3 gives a magnified view of a sea weed and a river weed. The larger specimen is the very delicate sea-weed of a red color, (plocamium

coccineum), which is collected so often on our coast for ornamental baskets, &c. The stem, crossing this, is a minute portion of the river silk, a green hair-like plant, common in ditches in the summer season. The whole of the smaller sea and river weeds are worthy of attention, and present infinite varieties of structure. Of flowering plants, who shall point out all their peculiarities? Every part of a plant contains something wonderful: the tissues, the vessels, and cells, the pollen, seeds, sections of the stem and root, hairs, and other minute appendages, folding of the leaf and flower in the bud, are but a very few of the wonders which the microscopist should regard, and which are adapted to the purposes of exhibition. Of these last subjects we have given some specimens in diagrams 4 and 5; 4 shows the hairs of plants.

No. 1 is a curious jointed hair of the marvel of peru; 2, a barbed hair of the borage; 3, bamboo-like hair of the xanthium spinosum; 4, a tufted hair of lavatera micans; 5, one of salvinia; 6, a forked hair of the indigo plant; 7, a toothed hair of hawkweed; 8, a beaded hair of spiderwort, while in the centre is a magnified view of the sting of a nettle. On the lower part is a bag of poison, from which arises an oblique pointed dart, which, being hollow, admits the poison to pass along it and into the wound.

Diagram 6 shows the manner that leaves fold themselves up in their winter quarters—the bud; ... consequently, any of the appearances represented may now be easily seen from the buds of the trees and shrubs. Each of these forms has an appropriate name, and remains constant to the particular plant in which it is found.

No. 1 is called *equitant*, as in the iris; 2, *imbricate*, as in the lilac; 3, *convolute*, as in the apricot; 4, *appressed*, as in the mistletoe; 5, *circinate*, as in the ferns; 6, *revolute*, as in the willow; 7, *involute*, as in the violet; 8, *obvolute*, as in the sage, and 9, *plaited*, as in the vine.

(To be continued.)

ON STEAM AS A CONDUCTOR OF ELECTRICITY.

BY DR. CHARLES SCHAFHAEUTL.

In the last number of the "Philosophical Magazine," the electricity obtained from a jet of high-pressure steam was considered to be of similar origin with that obtained from the insulated and separated positive metallic disc of Volta's electrophorus.

On this point, the first question which presents itself is, in what relation does steam or water-gas stand with the conductors or non-conductors of electricity.

It is well known that moist air is a conductor of electricity, and dry air, viz. air which contains less water-gas than it is capable of containing according to its temperature, is a non-conductor of electricity; but, besides this, I am not aware of any experiment made to ascertain the conducting power of pure steam without being in contact with water or mercury, and I therefore determined to ascertain this question by experiment.

The ends of a glass tube, about two inches long and a quarter inch interior diameter, were drawn out over a lamp to points, and bent upwards in a right angle. A thick platinum wire, with a small ring formed at each end, was then inserted into one end of the tube, and the glass melted around it air-tight. Water was then poured into the tube and boiled till only about two drops remained, when another platinum wire was inserted at the other end, and the hole quickly hermetically closed as before. The distance between the ends of the two wires in the tube was about one inch and a quarter, and the tube in this state contained of course nothing but water-gas and some liquid water.

This tube was now placed close to the bulb of a thermometer into a small sand-bath, and covered with the sand, excepting the two vertical ends.

One of these platinum wires was then connected with the outside of a Leyden jar, the other with an insulated discharger.

The Leyden jar, containing about 100 square inches armed surface, was now charged by means of fifty revolutions of a 12-inch glass plate, and then discharged through the tube as usual. The glass tube acted exactly as an imperfect conductor, interrupting the conducting wire, which connects the two surfaces of the jar, like a piece of wet cotton thread, or portion of glass tube moistened inside. The jar was perfectly discharged by the first touch, with that peculiar hissing noise and reddish fascicular stream of electricity which invariably occur under similar circumstances. The temperature of the sand-bath was now gradually raised, and at every 5° a similar electric discharge from the Leyden jar was passed through the tube. The same results were obtained until the thermometer reached 250°. At this point, by discharging the jar, a small red spark was obtained, instead of the former fascicular stream, and the jar was found to be entirely discharged, although the noise occasioned by the spark was scarcely audible, compared with the loud clap produced by the discharge of the jar under ordinary circumstances.

After the temperature had been elevated to 405°, the contents of the jar discharged with the usual brilliant spark and loud report, and at the same time the spark was seen passing through the tube. At this time no moisture could be detected in the tube, and the water-gas contained in it had entirely ceased to be a conductor of electricity, at the same time giving less resistance to the passage of the spark than common air, the striking distance having been elongated from half an inch to one inch and a quarter. When the temperature was reduced below 405°, the discharge passed as before mentioned, either as a small red spark, or in a fascicular stream, according to the temperature. When above 405° the spark passed as usual, until the temperature rose to 443, when the tube burst, which prevented me from ascertaining its weight with and without the water; the difference of which would of course have given me the weight of the water contained in the tube, the cubical contents of which would have been ascertained by filling it with quicksilver. If we assume that there were two drops of water in the tube when it burst, weighing together 0·73 grains, and supposing the contents of the tube to be 500 cubic lines, we have the pressure of 23·5 atmospheres therein.

From the preceding experiments we may conclude that steam, pure and free from contact with water, has, like all other gases, the property of being a non-conductor of electricity.

The facility with which the spark passes through the water-gas seems to be worthy of attention; the striking distance of the spark having increased from half an inch to one inch and a quarter; for, according to Mr. Harris's discoveries, the striking dis-

coveries, the striking distances are, in ordinary cases, in the inverse ratio to the density of the gas.

If we now consider the fact, that the electricity of a jet of condensed steam is, according to Mr. Armstrong's experiments, positive; that the quantity of electricity obtained from a jet of high-pressure steam is in proportion to its condensation; further, that the steam contained in the boiler presents no appearances of free electricity; and that, according to Mr. Pattinson's experiments, both water and boiler are negative, which is a necessary consequence of Mr. Armstrong's experiments;—we perceive a simultaneous development of electric polarity in opposite directions from a central or neutral point, as in the magnetic steel-bar; and this development of electric polarity can only be ascribed to the opposite changes of molecular arrangements, as well as chemical condition of the water and steam column; and we must consider both electric poles as co-existent and not separately.

Volta's electrophorus is only remarkable for the property of retaining its electricity for a lengthened period, and its action is entirely due to *induced electricity*, with which no one will confound the electricity obtained from steam. Besides, the disc of the electrophorus, from which the spark is obtained, must be a perfect conductor well insulated, and shows signs of free electricity only when it is, after a close contact with the electrophoric cake and neutralization of its free electricity, removed absolutely from the inducing cake. In a boiler filled with steam and water, neither of the above-mentioned circumstances can take place, and the positive electricity of the condensed steam, and the negative electricity of the boiler, are the only points ascertained by experiment. The electricity developed by evaporation, as the source of the observed free electricity, is only hypothetical.

Volta's experiment, of splashing water on ignited charcoal, can scarcely be considered as identical with the evaporation of water in a boiler; in the first instance, a mass of chemical decomposition and changes are taking place which never can occur in the latter, for even the sudden cooling of substances is sufficient to produce signs of free electricity.

If we ascribe the electricity of steam to its condensation, the circumstances under which that condensation takes place are likewise of great influence. The smallest jet of high-pressure steam developes more free electricity than 100 times greater quantity of low-pressure steam;—another condition under which electricity is produced from a jet of steam, seems therefore to be its *rapid expansion* when issuing from the boiler; or probably the quantity of caloric becoming latent during the expansion of high-pressure steam, has some relation to the quantity of electricity being set free. Even electricity in thunder-storms seems to be ascribable partially to the rapid currents of air whirling towards the centre of the clouds, as caloric is absorbed whilst the thunder-clouds are charging themselves.—*Philosophical Magazine.*

ALLOYS.

Alloys are a combination of two or more metals. The term is sometimes employed to denote the inferior metal combined with gold or silver. Thus, it is said, the standard gold of jewellers is 18 carets of gold and 6 of alloy. whatever metal the alloy may be. When metals are combined, either by fusion or cementation, the alloy, formed generally, possesses properties and characters very different from those of the respective components. The density is sometimes greater, sometimes less; the fusing point, in some cases, is considerably lower than the mean. Elasticity is sometimes communicated, sometimes destroyed; and the malleability and ductility of the alloy seldom correspond with those of the metals forming it. These important changes would lead to the inference, that alloys are chemical combinations, and not mechanical mixtures; but there are many objections to this supposition, the most important of which are, that metals may be combined in any proportions, and that they may be separated by the process called eliquation, if there is a great difference in the respective temperature of their fusing points. Thus silver and lead may be separated from copper by heat, the copper requiring a higher temperature for its fusion than the other two metals combined; and an alloy containing a volatile metal, as mercury, or zinc, may be decomposed by a strong heat, the fixed metal remaining when the more volatile is expelled. In many cases, a very small proportion of one metal is sufficient to change the most important characters of another. A quarter of a grain of lead will render an ounce of gold perfectly brittle, although neither gold nor lead are brittle metals. If a crucible containing arsenic be placed in the same fire with a crucible containing gold, the fumes of the arsenic will render the gold brittle. Some of the changes thus produced are of the utmost importance in the arts, as many of the alloys are far more valuable on account of the newly-acquired properties, than any of the simple metals. Gold and silver, in their pure state, would be totally unfit for the useful purposes to which they are applied, if they were unalloyed, on account of their softness. Even the standard current coin of the realm is alloyed, to render it hard, otherwise the impression would be speedily effaced, and the coin, by abrasion, would soon become deficient in weight. Pure copper would be unfit for many of the purposes in which it is so extensively applied in the arts, if it were not alloyed by some metal to give it hardness; and it is singular that the metals employed for this purpose are all soft metals. Brass, bell-metal, gun-metal, &c. are all alloys of copper with soft metals. Some metals which will not combine together immediately, may be united by the intervention of a third. Thus, mercury will not combine directly with iron; but if zinc or tin is first added to the iron, an amalgam may be formed of it with mercury. It may here be observed, that when mercury is united to any other metal, the compound is called an amalgam. In order to make a perfect alloy, a very intimate admixture, by mechanical agitation, should be effected while the metals are in the fluid state. They should, therefore, be either constantly stirred with an infusible rod, or repeatedly poured from one hot crucible to another. Mr. Hatchett found that the lower end of a bar of standard gold was of inferior specific gravity and value to the upper extremity, which would be formed by the last portions of the metal in the crucible. The surface of metals, also, should be carefully defended, while in the fluid state, from the action of the atmosphere, by a stratum of wax, pitch, or resin, if the fusing point be low; or by a layer of salt, pounded glass, borax, &c., if it be high. In this article we shall merely give a brief

account of the nature and composition of the most important alloys, and their respective uses. Where the mode of manufacture is complicated, and requires peculiar processes, we shall more fully describe them under their several heads.

Brass is composed of variable proportions of zinc and copper, according to the use for which it is required. In general, about 9 parts of zinc are added to 16 of copper when melted. The best brass is not made by the direct combination of the two fluid metals, but by the process called cementation. The vapour of the zinc ore, by this mode, combines more intimately with the copper.

Manheim Gold.—Three parts copper, 1 part zinc, and a small quantity of tin. If these metals are pure, and are melted in a covered crucible containing charcoal, the alloy bears so close a resemblance to gold, as to deceive very skilful persons.

Tombac, or *White Copper*, is formed of variable proportions of copper, arsenic, and tin.

Pinchbeck.—Five oz. pure copper, and 1 oz. zinc. The copper must be first melted before the zinc is added.

Prince's Metal is made of from 2 to 3 parts of copper, and 1 of zinc; or of common brass, with an extra portion of zinc.

Bell Metal.—Six to 10 parts copper, and 2 parts zinc. For small bells, a little zinc is added, and sometimes silver.

Tutania, or *Britannia Metal.*—Four oz. plate brass, and 4 oz. tin; when fused, add 4 oz. bismuth, and 4 oz. antimony. This composition is added at discretion to melted tin.

German Tutania.—Two drms. copper, 1 oz. antimony, and 12 oz. tin.

Spanish Tutania.—Eight oz. scrap iron, or steel, 1 lb. antimony, and 3 oz. nitre. The iron or steel must be heated to whiteness, and the antimony and nitre added in small portions. Two oz. of this compound are sufficient to harden 1 lb. of tin.

Queen's Metal.—Four and a half lbs. tin, ½ lb. bismuth, ½ lb. antimony, and ½ lb. lead. Or, 100 lbs. tin, 8 lbs. antimony, 1 lb. bismuth, and 4 lbs. copper. This alloy is used for making tea-pots and other vessels which imitate silver.

Red Tombac.—Five and a half lbs. of copper, and ½ lb. zinc. The copper must be fused in a crucible before the zinc is added. This alloy is of a red color, and possesses greater durability than copper.

White Metal.—Ten oz. lead, 6 oz. bismuth, and 4 drms. antimony. Or, 2 lbs. antimony, 8 oz. brass, and 10 oz. tin.

Gun Metal.—One hundred and twelve lbs. Bristol brass, 14 lbs. zinc, and 7 lbs. block tin. Or, 9 lbs. copper, and 1 lb. tin. Lead was formerly used in this alloy to facilitate the casting, but, at the battle of Prague, it was found that some of the pieces of ordnance, formed of this metal, were actually melted by the frequency of firing.

Blanched Copper.—Eight oz. copper, and ½ oz. neutral arsenical salt, fused together under a flux of calcined borax and pounded glass, to which charcoal powder is added.

Specula Metal.—Seven lbs. copper, 3 lbs. zinc, and 4 lbs. tin. These metals form an alloy of a light yellow color, possessing much lustre.

Metal for Flute Key Valves.—Four oz. lead, and 2 oz. antimony,

Printing Types.—Ten lbs. lead, and 2 oz. antimony. The antimony is added while the lead is in a state of fusion. The antimony gives hardness to the lead, and prevents its contraction when cooling. Some manufacturers employ different proportions of these metals, and some add copper or brass.

Small Type Metal.—Nine lbs. lead, 2 lbs. antimony, and 1 lb. bismuth. The antimony and bismuth are added when the lead is melted. This alloy expands in cooling; the mould is, therefore, entirely filled when the metal is cold, and no blemish is found in the letters. Stereotype plates are formed of this alloy. Some manufacturers employ tin instead of bismuth.

Common Pewter.—Seven lbs. tin, 1 lb. lead, 6 oz. copper, and 2 oz. zinc. The copper must be first melted before the other metals are added.

Best Pewter.—One hundred parts tin, and 17 parts antimony.

Hard Pewter.—Twelve lbs. tin, 1 lb. antimony, and 4 oz. copper.

Common Solder.—Two lbs. lead, and 1 lb. tin.

Soft Solder.—Two lbs. tin, and 1 lb. lead.

Solder for Steel Joints.—Nineteen dwts. of fine silver, 1 dwt. copper, and 2 dwts. brass.

Silver Solder for Jewellers.—Nineteen dwts. fine silver, 1 dwt. copper, and 10 dwts. brass.

Silver Solder for Plating.—Ten dwts. brass, and 1 oz. pure silver.

Gold Solder.—Twelve dwts. pure gold, 2 dwts. pure silver, and 4 dwts. copper.

Bronze.—Seven lbs. copper, 3 lbs. zinc, and 2 lbs. tin. The copper must be melted before the other metals are added.

Mock Platinum.—Eight oz. brass, and 5 oz. zinc.

Alloy of Platinum with Gold.—Fifteen parts pure gold, and 1 part platinum. The gold must be melted before the platinum is added. This alloy is whiter than gold. Platinum has the singular property of depriving gold of its peculiar color; if ten parts of gold are combined with only one of platinum, the alloy will appear of the color of platinum. There is another remarkable property attending this alloy of gold and platinum, that it is soluble in nitric acid, which does not act upon either of the metals in a separate state.

Ring Gold.—Six dwts. 12 grs. pure copper, 3 dwts. 16 grs. fine silver, and 1 oz. 5 dwts. pure gold. Jeweller's gold is made of variable proportions of pure gold and copper, and sometimes of silver.

Imitation of Silver.—One lb. copper, and ¾ oz. tin. This alloy will be of a deeper color than silver, but in other respects it is very similar.

Alloy of Platinum with Steel. — Platinum, although the most infusible of metals, when in contact with steel, melts at a comparatively low temperature, and combines with it in any proportion. This alloy does not rust or tarnish by exposure to a moist atmosphere for many months. The alloy is malleable and is well adapted for instruments which would be injured by slight oxidation, as mirrors for dentists, &c. The best proportions do not yet appear to be known; but it appears that if much platinum be used, the alloy has a damask or wavy appearance. Steel for cutting instruments is much improved by even 1-500dth of platinum.

Alloy of Silver and Steel.—Steel 500 parts, and silver 1 part. If a large proportion of silver is employed, the compound appears to be a mechanical mixture only. The silver is distinctly seen in fibres mixed with the steel, and the alloy is subject to voltaic action. When the proportion does not exceed 1-500, the compound appears to be a che-

mical union; the steel is rendered much harder, forges remarkably well, and is infinitely superior to the best cast steel for cutting instruments, &c.

Alloy of Steel with Rhodium.—If from 1 to 2 per cent. of rhodium be combined with steel, the alloy possesses great hardness, with sufficient tenacity to prevent cracking, either in forging or hardening. This alloy requires to be heated about 73° Fahr. above the best English cast steel in tempering. It is superior to that metal; but the scarcity of rhodium will prevent the extensive use of this valuable compound.

Fusible Alloys.—Four oz. bismuth, 2½ oz. lead, and 1½ oz. tin. Melt the lead first, and then add the other metals. This alloy will melt in boiling water, although the melting temperature of the several components is much higher; viz. lead. 612°; bismuth, 476°; tin, 442°.

LAUGHING GAS, OR NITROUS OXYDE.

Protoxide of nitrogen, nitrous oxide, or laughing gas, was discovered by Dr. Priestly, in the year 1776; he called it *dephlogisticated nitrous air:* it has also been called *gaseous oxide of azote.* It may be formed by exposing nitric oxide to the action of iron-filings, by which one equivalent of its oxygen is absorbed, and the remaining elements left in such proportions as to constitute nitrous oxide. But the gas thus procured is not pure. It is most easily and abundantly obtained in a state of purity, by heating, in a glass retort over an argand lamp, the salt called nitrate of ammonia, to a temperature of 420°. The gas which passes off, provided the salt be pure, and the temperature not too high, may be collected over warm water, and is pure nitrous oxide. If the nitrate of ammonia contain a mixture of the muriate, the gas will be contaminated by chlorine; and if too much heat be used in the decomposition of the pure salt (which may be known by white vapours appearing in the retort) it will contain nitric oxide. The salt should be kept in a state of gentle ebullition, so as to maintain a quick but not violent evolution of gas.

The presence of chlorine in nitrous oxide is ascertained by its smell, and may be avoided by pure nitrate of ammonia, the solution of which should not be rendered turbid on the addition of nitrate of silver. Nitric oxide is detected in it by the appearance of red fumes on mixing the gas with oxygen; it may be abstracted by agitating it with a solution of protosulphate of iron, which has no action upon nitrous oxide, but absorbs the nitric oxide, and acquires a deep olive color. If nitrous oxide be mixed with oxygen or with common air, it affords red fumes upon adding to it a few bubbles of nitric oxide, and it is not, as it ought to be, entirely absorbed when agitated with thrice its bulk of water.

One hundred cubic inches of nitrous oxide weigh 47.220 grains; its specific gravity, therefore to hydrogen, is as 22 to 1; and to atmospheric air as 1.534 to 1000.

The taste of this gas is sweet, and its smell peculiar, but agreeable. It is absorbed when agitated with water, which takes up about its own bulk, and evolves it unchanged when heated. It should, therefore, be collected and preserved in stopped bottles.

Nitrous oxide was generally considered not only as unrespirable, but as eminently noxious; the attempts, however, that had been made to breathe it, were with an impure gas: when obtained perfectly pure, Sir H. Davy found that it might be breathed when mixed with common air, without any injurious effects, and he afterwards ventured upon its respiration in a pure state, and discovered its singular effects upon the system, which in many respects resemble those of intoxication. The experiment of breathing this gas, however, cannot be made with impunity, especially by those who are liable to a determination of blood to the head. The following accounts will serve to give a general idea of its singular powers. They are quoted from Sir H. Davy's "Researches," in which many important details concerning the effects of different gaseous bodies upon the system will be found. The first account is by Mr. Tobin, and the second by Dr. Roget.

"On the 29th of April I breathed four quarts from and into a silk bag. The pleasant feelings, however, went off towards the end of the experiment, and no other effects followed. The gas had probably been breathed too long, as it would not support flame. I then proposed to Mr. Davy, to inhale the air by the mouth from one bag, and to expire it from the nose into another. This method was pursued with less than three quarts, but the effects were so powerful as to oblige me to take in a little common air occasionally. I soon found my nervous system agitated by the highest sensations of pleasure, which are difficult of description; my muscular powers were very much increased, and I went on breathing with great vehemence, not from a difficulty of inspiration, but from an eager avidity for more air. When the bags were exhausted and taken from me, I continued breathing with the same violence; then suddenly starting from the chair, and vociferating with pleasure, I made towards those that were present, as I wished they should participate in my feelings. I struck gently at Mr. Davy; and a stranger entering the room at the moment, I made towards him, and gave him several blows, but more in the spirit of good humour than of anger. I then ran through different rooms in the house, and at last returned to the laboratory somewhat more composed; my spirits continued much elevated for some hours after the experiment, and I felt no consequent depression either in the evening or the day following, but slept as soundly as usual."

Dr. Roget states as follows: "The effect of the first inspirations of the nitrous oxide was that of making me vertiginous, and producing a tingling sensation in my hands and feet: as these feelings increased, I seemed to lose the sense of my own weight, and imagined I was sinking into the ground. I then felt a drowsiness gradually steal upon me, and a disinclination to motion: even the actions of inspiring and expiring were not performed without effort; and it also required some attention of mind to keep my nostrils closed with my fingers. I was gradually roused from this torpor by a kind of delirium, which came on so rapidly that the air-bag dropped from my hands. This sensation increased for about a minute after I had ceased to breathe, to a much greater degree than before, and I suddenly lost sight of all objects around me, they being apparently obscured by clouds, in which were many luminous points, similar to what is often experienced on rising suddenly and stretching out the arms, after sitting long in one position. I felt myself totally incapable of speaking, and for some time lost all consciousness of where I was, or who was near me. My whole frame felt as if violently agitated: I thought I panted violently; my heart

seemed to palpitate, and every artery to throb with violence; I felt a singing in my ears; all the vital motions seemed to be irresistibly hurried on, as if their equilibrium had been destroyed, and everything was running headlong into confusion. My ideas succeeded one another with extreme rapidity, thoughts rushed like a torrent through my mind, as if their velocity had been suddenly accelerated by the bursting of a barrier which had before retained them in their natural and equable course. This state of extreme hurry, agitation, and tumult, was very transient. Every unnatural sensation gradually subsided; and in about a quarter of an hour after I had ceased to breathe the gas, I was nearly in the same state in which I had been at the commencement of the experiment. I cannot remember that I experienced the least pleasure from any of these sensations. I can, however, easily conceive, that by frequent repetition I might reconcile myself to them, and possibly even receive pleasure from the same sensations which were then unpleasant. I am sensible that the account I have been able to give of my feelings is very imperfect. For, however calculated their violence and novelty were to leave a lasting impression on the memory, these circumstances were for that very reason unfavorable to accuracy of comparison with sensations already familiar. The nature of the sensations themselves, which bore greater resemblance to a half-delirious dream than to any distinct state of mind capable of being accurately remembered, contributes very much to increase the difficulty. And as it is above two months since I made the experiment, many of the minuter circumstances have probably escaped me."

Nitrous oxide is not permanently elastic; for by subjecting it to a pressure of about 50 atmospheres at the temperature of 56°, Mr. Faraday obtained it in the liquid form. It was thus procured by sealing up some nitrate of ammonia in a bent tube and heating it, while the other end was kept cool. Many explosions occurred with very strong tubes, and the experiment is always attended with risk. The tube, when cooled, is found to contain two fluids: the heavier is water, a little acid; the lighter, liquid nitrous oxide; it is limpid, colorless, and so volatile, that the heat of the hand generally makes it disappear in vapor. The application of ice and salt condenses it again. It has not congealed by cold. Its refractive power is less than that of any known fluid. A tube being opened in the air, the nitrous oxide immediately burst into vapor. Another tube was opened under water, and the vapor collected and examined proved to be nitrous oxide.

Nitrous oxide supports combustion, and a taper introduced into it has its flame much augmented, and surrounded by a purplish halo. Phosphorus and sulphur, when introduced in a state of vivid ignition into this gas, are capable of decomposing it, and burn with the same appearance nearly as in oxygen; but if, when put into the gas, they are merely burning dimly, they then do not decompose it, and are extinguished; so that they may be melted in the gas, or even touched with a red-hot wire without inflaming. Charcoal, and many of the metals, also decompose nitrous oxide at high temperatures.

At a red heat this gas is decomposed, and two volumes of it are resolved into two volumes of nitrogen and one volume of oxygen, so that it thus suffers an increase of bulk.

The analysis of this gas may also be effected by detonation with hydrogen. When a mixture of one volume of nitrous oxide and one volume of hydrogen is fired by the electric spark, water is produced and one volume of nitrogen remains. Now, as one volume of hydrogen takes half a volume of oxygen to form water, nitrous oxide must consist of two volumes of nitrogen and one volume of oxygen; these three volumes being so condensed, in consequence of chemical union, as only to fill the space of two volumes.

Note.—It may be advisable to remark, that the gas, if not pure, is highly dangerous to inhale; to test if it be so, it is only necessary to hold a candle before a small jet of it. If pure, the flame will appear large and yellow. To administer it, procure a bladder, which will hold about 2 gallons, and furnish it with a wide mouth-piece, such as a tube about ¾ of an inch in diameter. The bladder having been filled with gas, direct the person who is to receive it, to sit down on a chair, and to hold his nose, so that he shall be obliged to breathe through his mouth; then let him make a full expiration of all the air in his lungs, and instead of inhaling common air again, the operator must put the bladder to his mouth, and hold it there. The person who receives it will in about a minute show the effects.

ON THE EPOCHS OF VEGETATION.

BY M. HENRY BERGHAUS, OF BERLIN.

NATURE has made essential distinctions in the period of germination, which, as is well known, are in a great measure caused by the constitution of the seeds themselves. Thus rye, millet, and most of the cerealia, germinate in two or three days; lettuce, the gourd, and the water-cress, in from five to seven; the bean and onion in about twenty; parsley in forty days; columbine, the almond, the peony, the hazel-nut, &c. in from six to eight months; and, finally, the rose germinates between the first and second year.

As caloric is the most powerful of the agents which operate upon vegetation, so must it also exercise the greatest and most direct influence on germination. Consequently the principle may be adopted that this phenomenon of vegetable growth stands constantly in connexion with the different degrees of temperature of the soil by which the seeds are surrounded.

We recognise a more evident proof of the truth of this principle in the fact that the seeds of tropical plants, when sown in temperate climates, germinate much later than in their native soils; while the germination of seeds of colder countries is extraordinarily hastened by their being sown in temperate climates.

Hence, in the greenhouses of our botanic gardens, we must elevate the temperature considerably in order to induce germination in the seeds of tropical countries; and hence we must shelter the seeds of northern countries in the coldest and most shady spots in order to hasten their vegetation.

The difference of temperature, likewise, which occasionally occurs in one and the same season in different years exercises a great influence on the epochs of germination. In fact, we not unfrequently see that seeds of the same plants germinate much earlier when the spring arrives soon, and a mild rainy winter had preceded it, but much later when the heat of spring has been delayed by a severe winter.

Frondescence, that is the unfolding of the leaf-buds, is subjected to the same changes which are observable in the germination of seeds; for the difference of climate and that of the seasons exercise the greatest influence on this second epoch of vegetation.

The lilac *(Syringa vulgaris)* unfolds its leaves,
In the neighbourhood of Naples (lat. 41°), in the first half of the month of January.
In England and near Paris (lat. 49°), as observed during many years, on the 12th March, as a mean.
In the middle districts of Sweden, Upsala (lat. 60°) at the beginning of March.

The elm (*Ulmus campestris*) unfolds its leaves,
At Naples, at the beginning of February;
At Paris, in the month of March;
In England, on the 15th April;
At Upsala, in the middle of March.

The birch (*Betula alba*) unfolds its leaves,
At Naples, in the month of March;
At Paris, in April;
In England, the 29th March;
At Upsala, in the first days of May.

The beech (*Fagus sylvatica*) unfolds its leaves,
At Naples, towards the end of March;
In England, the 1st May;
At Upsala, in the first days of May.

The lime-tree *(Tilia)* unfolds its leaf-buds,
At Naples, towards the end of March;
In England, the 13th April;
At Upsala, in the first days of May.

The Oak (*Quercus*) unfolds its leaves,
At Naples, the beginning of April;
At Paris, in May;
In England, the 26th April;
At Upsala, the first days of May.

Investigations made regarding the various periods of the development of the flowers or efflorescence in the middle latitudes of Europe and North America, according to a communication made by the late M. Schübler, prove, as a general result, that the development of flowers is four days later for each degree of latitude towards the north. According to corresponding observations which were made, at the request of M. Schübler, by the naturalists assembled at Berlin in the autumn of 1828, during the following summer at Parma in Lombardy, and in various places farther to the north, it appears that the same plants flower at Zurich six days later than at Parma, at Tubingen thirteen days later, at Jena seventeen, at Berlin twenty-five, at Hamburgh thirty-three, at Greifswald thirty-six, and at Christiana no less than fifty-two days later than at Parma.

This likewise holds good in a corresponding way with vegetation at points at a higher elevation. In a district lying 1000 feet higher, the growth of plants, in our geographical position, is rendered at least ten to fourteen days later.

In Saxony the following observations were made in the years 1833 and 1834, regarding some of the periodical phenomena of the vegetable kingdom which depend on the influence of the climate; and the subjects of these experiments were the chief plants used as food.

In higher latitudes, in districts situated in the north of Germany, the development of vegetation is less retarded than in more southern positions; the delay of the development of efflorescence between Hamburgh and Christiana amounts to only 3.4 days for one degree's approach towards the north, while that between Southern Germany and Smyrna in Asia Minor, which is in the same parallel as the most southern portions of Europe, amounts for the same space to 7.4 days.

The cause of this difference arises from the different lengths of the days, which in higher latitudes, during the warm period of the year, increase in a much greater degree than they do in southern parallels, by which the vegetation is hastened into development more speedily; and it is only in this way that it is possible in higher latitudes for various summer plants to reach their requisite maturity.

Some plants exhibit in this respect remarkable differences; the activity of vegetation is not increased in equal proportions in different plants by the same elevation of temperature. Plants of northern climates are less retarded in their development at the same low temperature than are plants of more southern regions.

(To be continued.)

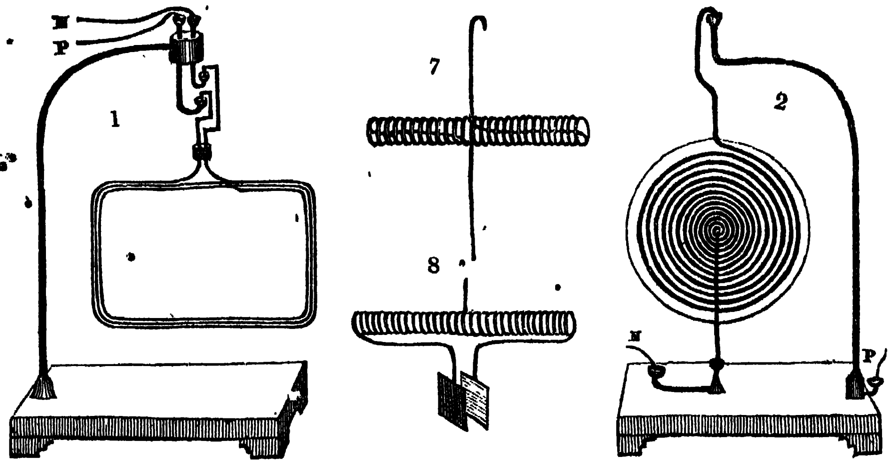
MISCELLANIES.

Effects of Winds upon the Atmosphere.—The following laws have been deduced from extended experiments by Kamtz and Dove. 1. The barometer falls under the influence of the east, south-east and south winds; the descent changes to ascent by the south-west wind; rises by the west, north-west and north winds; the ascent changes to descent by the north-east wind. This law is deduced from observations, made as Paris four times a day, at first for five years, then for ten years, 1816-25. 2. The thermometer rises by the east, south-east and south winds; the ascent changes to descent by the south-west wind: falls by the west, north-west and north; the descent changes to ascent by the north-east wind. This and the following are believed to be based upon observations made at Paris and London, and have been confirmed by observations of Kamtz himself during four years. 3. The elasticity of aqueous vapor is increased by the east, south-east, and south winds; its increase changes to decrease by the south-west wind; it decreases by the west, north-east, and north winds, and its decrease changes to increase by the north-east wind. 4. The humidity of the atmosphere decreases relatively from the west wind, passing by the north to the east, and increases, on the contrary, from the east by the south to the west.—*Inventors' Advocate.*

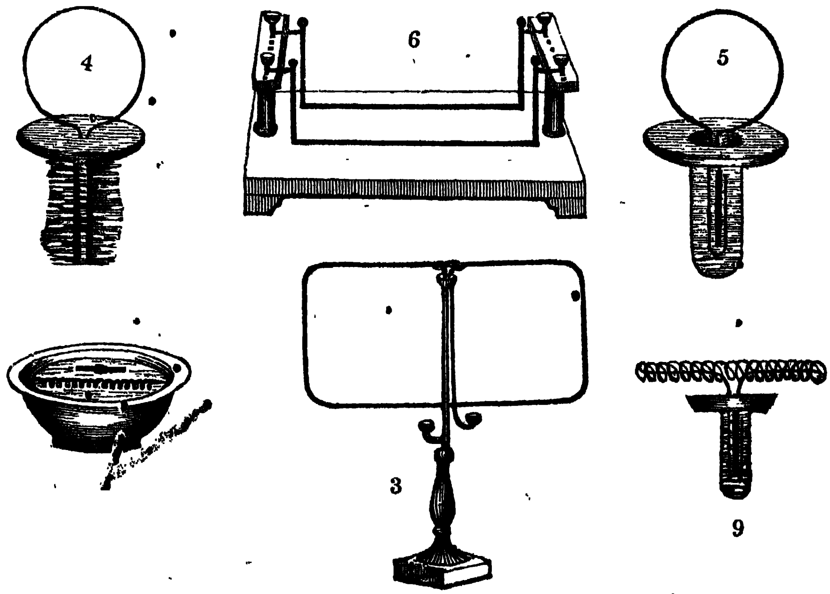
Melting Snow with Salt.—People are in the habit of sprinkling salt upon snow before their doors. They could not do a more silly or injurious thing. The result is to change dry snow or ice at the temperature of 32 to brine at 0. The injurious effect of damp upon the feet at this excessive degree of cold is likely to be extreme. If, then, any one does sprinkle salt upon snow in the street, he ought to feel it a matter of conscience to sweep it away immediately.—*Faraday.*

Perfume of Flowers.—According to the experiments of MM. Schübler and Kohler of Tubingen, white flowers are the most numerous in creation, and the most odoriferous; and to these succeed the red flowers.

New Black Ink.—A very beautiful black ink, of easy preparation, may be made from the flowers of the Iris.—*Athenæum.*



ELECTRO-MAGNETISM.



ELECTRO-MAGNETISM.

(*Resumed from page 299.*)

In our resumption of the subject of electro-magnetism, it is necessary, before proceeding to the rotative experiments, to show more particularly than we have hitherto done, the magnetic effects induced in various metallic substances, when the electric fluid is made to traverse them; confining our attention chiefly to the attractions and repulsions such magnets exhibit, and the similar polarity they exhibit to ordinary magnets. Let it be remarked here, that the term electro-magnetic means not merely a steel or iron bar made magnetic by electricity, but also any coil or arrangement of wires through which the electric fluid is passing in such a manner as to make it put on the properties of a magnet.

We have already seen in an introductory paper on this subject, (page 171) that when a common wire transmits a current of electricity, its two sides become magnetic; one side showing the effects of a north pole, the other side that of a south pole. Now if the wires be multiplied, so the effect will be multiplied also; and from a coil of wire we shall have a series of north poles pointing one way and an equal series of south poles turning the contrary way; and these, if the current be strong and the connections good, will have considerable directive and attractive force.

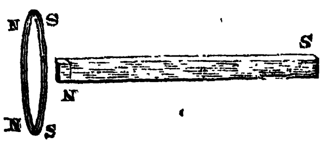
The apparatus represented in Fig. 1, illustrates some of these principles. It consists of a flat parallellogram of covered copper wire, bent so as to dip into two mercury cups above and remaining suspended beneath. The lower portion of the wire may be bent only once, or it may make several rings, in either case acting in the same manner, and with nearly equal power. The stand bears a brass support, terminating in a round piece of wood at top, through which pass two wires, each of which is terminated at either end with mercury cups. When the points of the wire frame are placed in their appointed cups, and a current of the electric fluid from a small battery is made to traverse the wire, it will move itself gradually round until it reaches a situation transverse with the magnetic meridian, or in other words, will be nearly east and west; one side of the wire having north polarity, the other side south polarity.

The same result is shown by the use of Sturgeon's spiral card, Fig. 2. This is a circular piece of card with a wire terminating in a point at top, and continued in a spiral form over the surface of the card till it arrives at the middle, where the wire passes through the card and being passed straight downwards, rests in a mercury cup on the foot. The battery current being made to pass over through the wire, the instrument arranges itself as the last, that is, east and west, or across the magnetic meridian.

Another apparatus, invented by Mr. Sturgeon, is of similar delicacy and equally shows the effect of the passage of a stream of the electric fluid in inducing polarity. This apparatus is represented in Fig. 3. It consists of a paralellogram of wire, one end of which is connected with the mercury cup at the top of the stand, the other end terminating in a similar cup; as soon as the current is passed around the paralellogram, it turns itself in a manner accordant to the former instruments. Another fact is also brought before our notice, by having two of these instruments, that similar poles repel each other and opposite poles attract, just the same as in the ordinary magnet, showing that electro-magnets are analogous to others in the effect of attraction and repulsion, as well as in dip and polarity.

The ingenious apparatus of M. de Rive, is still more conclusive, and enables us to prove still better than by the above, the laws by which the above and similar implements are affected. De Rive's floating battery is represented in its simplest form in Fig. 4. It consists of a ring of wire, about 1 inch in diameter, holding a small strip of zinc at one end and another small strip at the other end, the whole being inserted into a cork to render it buoyant. This is then floated in a basin of acidulated water, and small as it is, yet there will be a sufficiency of fluid disturbed to make the little apparatus arrange itself east and west, one side of the wire being north and the other side south. (It is proper to remark that if the ring of wire be made by twisting the wire round several times the instrument will be more powerful.) We have now to prove that one side of this ring of wire is really north and the other really south, and this is done by presenting to either side the pole of a bar magnet, when using the same pole it will be attracted in the one instance and repelled in the other. And the manner of this attraction and repulsion forms one of the most singular and apparently incomprehensible phenomena, that the whole range of science produces. First, we must premise, that the floating battery be in a sufficiently large basin to allow it perfect freedom of motion, and the bar magnet held towards it be small enough to pass easily through the ring of wire, then holding one pole of the magnet to the side of the ring where it is attracted, the ring will gradually approach the magnet, will pass over it and slide along until it arrives at the centre of the magnet, where it will stop; if now the ring be held still and the magnet drawn out, and placed in the same position as before, but with the poles reversed, it is just possible that the ring may be in the point of equilibrium as before, but if inclined a little away from this point, it will, instead of sailing to the centre again, move outwards, and be thrown off the end of the magnet with some force, it will then turn itself round, and presenting its other side, will gradually slide back again to the centre of the magnet as at first.

The explanation of this phenomenon, singular as it is, is very easy, as will be seen by the following cut, which represents a bar magnet, and a side view of the floating ring.



Suppose the current is so passing, that the side of the ring nearest to the magnet is south, and that the north pole of the magnet be presented to it. It is evident, that the pole of the magnet and the side of the ring nearest to it are in opposite states, attraction therefore takes place, and the ring slides over the pole of the magnet; at this exact point, the pole itself exerts no influence, but the whole of that end of the magnet is endowed with north polarity, more or less; therefore the ring is still attracted beyond the exact polar point, and as soon as it is so, be it but by a hair's breadth, the north side of the ring is opposed to the north pole of the magnet, and repulsion takes place between them, and the ring is urged forwards with renewed impulse; this

impulse however, gradually lessens, until the ring attains the central point, when the south pole of the magnet exerts its power to stop it from coming further. The second case, when the ring sails outward, is no less easily accounted for; we have only to suppose the magnet turned end for end, and the ring resting near the middle of it, when the same causes, but differently exerted, occasion that effect also.

Fig. 5, shows an improvement upon M. de Rive's apparatus, suggested by Mr. Marsh; the ring of wire and cork is as before, but the strip of copper is made to surround the zinc, and the metals, that is, the zinc and copper, are inclosed in a small glass tube; this being filled with acid and water, there is no necessity that the water in the basin should be acidulated, thereby taking away the expense and annoyance of a large quantity of materials.

Another apparatus was invented by Mr. Faraday, to show the attractive and repulsive effects of two streams of electric fluid passing along wires placed near to each other, (see Fig. 6.) If the current of one battery be made to pass along the foremost wire, and a current from a second battery be made to pass along the second wire in the same direction, the wires will attract each other; but if one of these currents be reversed in direction, the wires will repel each other.

Now we come to consider helices, or longitudinal coils, such as that represented in Fig. 7. If a coil of this kind be suspended instead of the flat coil in Fig. 3, the result will be, that one end of it will point to the north, and the other to the south, exactly as an ordinary magnet, and this for the same reason, as the flat coil (No. 2,) turns its sides to the north and south. If we examine one of these helices, we find that each ring of it has north polarity on one side, and south on the other: now supposing there are ten rings or coils, there would be ten north poles, all pointing one way, and ten south poles, the contrary. We also find every one of these poles, except one north pole at one end, and one south pole at the other end, has a contrary pole next to it, therefore nine north poles and nine south poles neutralize each other, and there remains but two to induce the motion of the whole machine; but these two poles are distant from each other, having the same influence one upon the other, and being influenced by the same causes as a common suspended bar magnet, which it exactly resembles in every particular of action.

This will explain the north and south polarity, which the modification of M. De la Rive's, shown in Figures 8 and 9, exhibit when left floating, the one in common water, the other, acidulated water. The explanation of these electro-magnets has already led us too far to enter at present into the subject of the influence of one electrical current upon another, in producing rotations; but the particular part we have now endeavoured to elucidate would be incomplete, did we not observe, that every experiment of the kind may be exactly imitated by magnetism alone, and that all these electro-magnets are influenced by the approach of artificial and natural magnets; for example, lay one of the coils used to convey a small current of the electric fluid across a basin of water, and near it, supported by a cork, (see Fig. 10,) lay a small magnet; it will be seen that the magnet will be attracted to one part of the coil, and repelled by the other; it will, if properly placed, sail to the end of the coil, and turning endwise, enter it, and gradually approach the centre, where it will fix itself, in the same manner as in one of the preceding experiments: the ring of wire slided over the magnet that was held firm, and so on for the rest.

(To be continued.)

ON THE EPOCHS OF VEGETATION.

(*Resumed from page 336, and concluded.*)

Between Perth-Amboy, on the east coast of North America and Naples, there is a difference in the flowering period of the peach-tree of ten weeks, although the two places are nearly under the same parallel; and there is a difference of six weeks in the case of the pear-tree, and eight in the apple. Perth-Amboy, however, lies on the isothermal parallel of 12½°, while Naples is nearly on that of 17°. At the former place, the winter has a temperature of only 32°.54 F., and at the latter of 50°F. The mean temperature of April at New York (lat. 40° 40′) is 49°.1 F., and at Tubingen 48°.2 F. *Amygdalus persica* therefore requires for the development of its blossoms at least 48°.2 F., and Naples has that temperature in the month of February.

The third epoch of vegetation, the ripening of the fruit, or fructification, is subjected to the same variations as the preceding epochs, both as regards the influence of the thermal nature of the season for one and the same place, and the difference of climates in different latitudes.

The wheat harvest begins in the neighbourhood of Naples in June, in Central Germany in July, in the south of England, and in the middle districts of Sweden, on the 4th August.

The barley harvest takes place at Naples in June, in Central Germany in about the end of July or beginning of August, in England on the 14th August, and in the middle districts of Sweden on the 4th August.

Ripe cherries are to be had in Naples in the first days of May, in Paris towards the end of June, in Central Germany about the end of June, and in the south of England not till the middle of July.

Owing to the comparatively higher temperature which prevails in summer in Sweden, and to the more rapid vegetation there than in England, the wheat harvest does not take place sooner in the south of England than at Upsala, but occurs about the same time; and barley is ten days later of ripening in England than in Sweden. For July, in England, has a mean temperature of 60°.8 F., and about 62°.6 F. at Upsala; and August in England, has a mean temperature likewise of about 60°.8 F., and in Sweden about the same, viz. 60°.26 F.

If we adopt the observations made during two years in Saxony, we find, as the mean result, that, from efflorescence to ripeness of fruit, 56 days are required for wheat, 59 for rye, 31 for barley, 45 for oats, and 68 days for the potato.

According to the observations made in Würtemburgh, which were continued for several years, the same period of vegetation required 56.4 days for rye, 42½ for *Triticum spelta*, 51½ for winter barley (*Hordeum vulgare*), 25 for summer barley (*Hordeum æstivum*), and 25½ days for oats.

In the portion of the valley of the Elbe, which is in Saxony, taking the mean of the two years 1833 and 1834, the vine flowered on the 17th June, and the vintage began on the 16th October. Between the two epochs there is a period of 121 days. In Würtemberg, the *Vitis vinifera* requires

119.3 days; and near Stuttgart the vintage commences on the 15th October, taking the mean of 65 years.

From the comparison of the Saxon data, there results that, for every 100 feet, there is a delay

	In flowering.	*In the harvest.*
Of wheat,	2.2 days	2.2 days
Of rye,	1.3	2.2
Of oats,	2.0	1.4
Of barley,	2.2	2.2
Of potatoes,	2.3	0.5

The approximate results differ considerably from the determinations calculated by Schübler.

As to the fall of the leaf or defoliation, the hazel-tree, the ash, the lime, the poplar, and the maple, lose their leaves at Upsala at the very beginning of autumn; while in the neighbourhood of Naples they remain in full foliage during the whole month of November. The apple-tree, the fig-tree, the elm, the birch, and the different kinds of oak, which in Paris are deprived of their leaves at the beginning of November, retain them at Naples till the end of December.

In England, the walnut is one of the first trees which loses its leaves; and after it the mullberry, the ash, especially when it has had much blossom, and then the horse-chesnut. All supported trees so long as their heads are sound, retain their leaves for a long time. Apple and peach trees often remain green till the end of November. Young beeches never cast their leaves before the new year, and only do so when the new leaves force them off; tall beeches lose their leaves towards the end of October.—*From Berghaus's Almanac for* 1840.

ADVANTAGE GAINED BY HEATING GAS BEFORE BURNING.

The efficacy of the patent lately taken out by Mr. Smith, of Leamington, for a hot gas burner, in which the gas is heated by the flame before it is consumed, was tested by Mr. J. T. Cooper, in a series of experiments, of which the following are the results, as given by himself in a letter to Mr. Smith:—

"I find that when your patent form of apparatus is used with any argand burner, that the average increase of light from the consumption of the same quantity of gas, as ascertained by a great number of experiments, is in the ratio of 119 to 100, or an increase of nearly one-fifth; for with the gas which I employed, the consumption of 7½ feet per hour gave, when consumed by an argand burner of 16 holes, without your apparatus being attached, a light equal to 16¾ candles, and with the consumption of the same quantity, in the same time, and with the same burner, with your apparatus added, the light produced was equal to 20 candles.

"Although I felt in a great measure satisfied with the results I had obtained by this method of experimenting, yet I thought it desirable to vary the mode of operating, which I did in the following manner:—Having accurately adjusted two of Mr. Crosley's experimental meters, so that they registered precisely the same, I selected two similar Dixon's burners, and attached one of them to one of the meters, with your patent apparatus added, and the other to the other meter, without your patent apparatus, and regulated the supply cock to each, so that they gave shadows of equal intensity. A considerable number of experiments were made in this way in order to obtain an average, the gas being supplied to both burners from a gas-holder, constructed to give equal and uniform pressures; the results were that the hot gas burner consumed 5·3 feet per hour, while the burner arranged in the common way for an equal intensity of light was consuming 6·43 feet, which is in the rate of 100 to 121·3.

"In order to be certain that there was no difference to be attributed to any slight difference in the construction of the burners themselves, they were reversed, that is, the burner which had been used with the hot gas apparatus was applied to the ordinary mode of burning, and vice versa; the average results obtained were, the hot gas burner consumed 5·6 feet per hour, and the other 6·65 feet per hour, which is in the rate of 100 to 119.

"Now in the first series of trials, the ratios were as 100 to 121·3, and in the second as 100 to 119, the mean of which is, as 100 to 120, or an increase in illuminating intensity of 20 per cent.; which accords as near as can be expected with the first obtained results, and by methods so different, that I am induced to place the greatest reliance on their accuracy.

"The difference of increase in illuminating intensity by the use of the hot gas apparatus, is however more remarkable when the common bat-wing burner is employed; for I found that when two similar burners of this kind were substituted for the argands, as in the former experiments, and being adjusted by their regulating cocks, to produce equal intensities of light, as determined by shadows, while that burner which was attached to the hot gas apparatus was consuming 4·36 feet per hour, the other which had not the advantage of the hot gas apparatus was burning 5·9 feet per hour; these as in the former cases, being averages of a number of trials. The burners were then reversed as in the former experiments, and the results obtained were precisely the same; the ratios in these instances being as 100 to 135·3, or nearly 40 per cent."—*Inventors' Advocate.*

GUM.

(*Resumed from page* 325, *and concluded.*)

THIRD SPECIES.

Common Gum.—This is what exudes from the bark and even from the pericarp of our fruit trees, such as the almond, the plum, the peach, and even the apple tree, at the period of the maturity of the fruits, that is when the vegetable, passing into a state of temporary repose, has no longer any woody textures to elaborate. In consequence of the cracks which it occasions in making its way to the surface, this exudation of a substance tending to organize is, by gardeners, reckoned a disease of the trees; and it is checked by paring the surface to the quick and covering the wound with a mixture of wax and turpentine, or, which is better, with a mixture of clay and cow dung, to exclude the air.

This product is an object of commerce, and much used in the arts in place of gum arabic on account of its cheapness. Common gum is more colored, less hard, and not so brittle as gum arabic. It is also less soluble, and its solution is less viscid. It contains gallic acid which renders it astringent. It is not completely precipitated by alcohol, and the

subacetate of lead does not act on it until after they have been twenty-four hours mixed. It is not disturbed either by the salts of iron, or by silicate of potash, nitrate of mercury, or infusion of galls, but it is coagulated by chloride of tin.

FOURTH SPECIES.

If we view in connexion with what has been already said, 1st, respecting gluten, a substance capable of imbibing water almost to an unlimited extent, and even becoming soluble in water or alcohol by means of an acid or an alkali; 2d, respecting the phenomena of the growth of woody textures; and, 3d, respecting the part which gum acts in the formation of the textures and the consequently indispensable necessity for its presence in the cells of every texture, whether woody or glutinous;—we shall have little difficulty in admitting that the results of many analytical inquiries may be affected by a similar connexion actually existing; in other words, that, in consequence of the tearing or decomposition of the textures, a portion of gluten more or less altered, and of the debris of the woody texture, may be carried along with the gum which exudes; so that the substance which will then be presented to us, instead of forming a limpid solution like gum, will form a more or less consistent mucilage. To diminish this consistence it will be necessary to employ considerable quantities of water, especially if we have to treat the substance after it has been dried. This mucilage will pass through the filter not in drops but in retractile threads, the filter will soon be obstructed, and the matter left on it will be found to consist of those textures which are the farthest advanced in development. It may happen that alcohol will not precipitate the whole of a mixture such as this, owing to the presence of an acid. The alkalis and certain acids will destroy the cohesion of the organized substance, and give to it the solubility of the substance, tending to organize. The precipitates obtained by means of reagents will be different, according to the nature of the salts contained in the organ which is analyzed, and which are, of course, dissolved by the water employed to extract the gum from it.

These principles, now so evidently incontestible, must have escaped the notice of those who adhered to the old methods of analysis. Accordingly, they indulged themselves without scruple in the pleasure of creating almost as many names as there were mixtures of this sort submitted by them to experiment. Thus gum bassora, gum tragacanth, cherry-tree gum, the gum of the plum tree, linseed, the seeds of the quince, the bulbs of the hyacinth, the roots of the marshmallow, the tubercles of the orchis, &c. &c. have furnished each a variety of this mucilage. But, when the attention has once been drawn to the subject, it is sufficient to glance over the descriptions of these illusory substances to see the reason of the differences which they exhibit. It is worthy of remark that these substances, when distilled, yield much more ammonia than gum arabic does; that they are changed by the action of nitric acid into mucic, malic, and oxalic acids; that they swell up when steeped in water; and, above all, that by agitation with water they render it milky.

In order to separate the gum from the textures blended with it in these mixtures, we would advise that they should be treated with carbonate of lime, to saturate the disguised acid to which the gluten may owe its solubility, that they should then be dried by a moderate heat, and that the mass should be steeped in water for several days, after which the limpid part should be cautiously decanted. We do not, indeed, thus obtain the whole of the gum, but we have a solution containing nothing but gum.

The elementary analysis of gum tragacanth was executed by Hermann, who did not find in it the smaller proportion of carbon than gum arabic.

Carbon, 40.50; oxygen, 52.89; hydrogen, 6.61.

Acetate and subacetate of lead, chloride of tin, and nitrate of mercury, precipitate the mucilage of gum tragacanth, of linseed, and of quince seeds. The infusion of galls renders the first turbid, but not the other two. The silicate of potash does not act on any of them.

Applications.—Gum arabic is used to give lustre to silk and other stuffs, to render colors laid on paper more brilliant, to give cohesion to fumigating pastiles, and to keep suspended in water coloring or other matters which would otherwise subside. The mucilage of linseed is used in medicine for the preparation of emollient cataplasms, and emulsions are prepared with that of gum tragacanth.

But it ought to be remembered in therapeutics that these gums being, in general, mixtures of various substances, it cannot be admitted *a priori* that they may be indiscriminately substituted for each other. This is a point which experience must decide.

INDIAN STEEL, OR WOOTZ.

The wootz ore consists of the magnetic oxide of iron, united with quartz, in proportions which do not seem to differ much, being generally about 42 of quartz, and 58 of magnetic oxide. Its grains are of various size, down to a sandy texture. The natives prepare it for smelting by pounding the ore, and winnowing away the stony matrix, a task at which the Hindoo females are very dexterous. The manner in which iron ore is smelted and converted into wootz, or Indian steel, by the natives at the present day, is probably the very same that was practised by them at the time of the invasion of Alexander; and it is a uniform process, from the Himalaya mountains to Cape Comorin. The furnace, or bloomery, in which the ore is smelted, is from 4 to 5 feet high; it is somewhat pear-shaped, being about 2 feet wide at bottom, and 1 foot at top; it is built entirely of clay, so that a couple of men can finish its erection in a few hours, and have it ready for use the next day. There is an opening in front, about a foot or more in height, which is built up with clay at the commencement, and broken down at the end, of each smelting operation. The bellows are usually made of a goat's skin, which has been stripped from the animal without ripping open the part covering the belly. The apertures at the legs are tied up, and a nozzle of bamboo is fastened in the opening formed by the neck. The orifice of the tail is enlarged and distended by two slips of bamboo. These are grasped in the hand, and kept close together in making the stroke for the blast; in the returning stroke they are separated to admit the air. By working a bellows of this kind with each hand, making alternate strokes, a pretty uniform blast is produced. The bamboo nozzles of the bellows are inserted into tubes of clay, which pass into the furnace at the bottom corners of the temporary wall in front. The furnace is filled with

charcoal, and a lighted coal being introduced before the nozzles, the mass in the interior is soon kindled. As soon as this is accomplished, a small portion of the ore, previously moistened with water, to prevent it from running through the charcoal, but without any flux whatever, is laid on the top of the coals, and covered with charcoal to fill up the furnace.

In this manner ore and fuel are supplied; and the bellows are urged for 3 or 4 hours, when the process is stopped; and the temporary wall in front being broken down, the bloom is removed by a pair of tongs from the bottom of the furnace. It is then beaten with a wooden mallet, to separate as much of the scoriæ as possible from it, and, while still red-hot, it is cut through the middle, but not separated, in order merely to show the quality of the interior of the mass. In this state it is sold to the blacksmiths, who make it into bar iron. The proportion of such iron made by the natives, from 100 parts of ore, is about 15 parts. In converting the iron into steel, the natives cut it into pieces, to enable it to pack better in the crucible, which is formed of refractory clay, mixed with a large quantity of charred husk of rice. It is seldom charged with more than a pound of iron, which is put in with a proper weight of dried wood chopped small, and both are covered with one or two green leaves; the proportions being in general, 10 parts of iron to 1 of wood and leaves. The mouth of the crucible is then stopped with a handful of tempered clay, rammed in very closely, to exclude the air. The wood preferred is the *Cassia auriculata*, and the leaf, that of the *Asclepias gigantea*, or the *Convolvulus laurifolius*. As soon as the clay plugs of the crucibles are dry, from 20 to 24 of them are built up in the form of an arch, in a small blast furnace; they are kept covered with charcoal, and subjected to heat urged by a blast for about two hours and a half, when the process is considered to be complete. The crucibles being now taken out of the furnace, and allowed to cool, are broken, and the steel is found in the form of a cake, rounded by the bottom of the crucible. When the fusion has been perfect, the top of the cake is covered with striæ, radiating from the centre, and is free from holes and rough projections; but if the fusion has been imperfect, the surface of the cake has a honeycomb appearance, with projecting lumps of malleable iron. On an average, four out of five cakes are more or less defective. These imperfections have been tried to be corrected in London, by re-melting the cakes, and running them into ingots; but it is obvious, that when the cakes consist partially of malleable iron, and of unreduced oxide, simple fusion cannot convert them into good steel. When care is taken, however, to select only such cakes as are perfect, to re-melt them thoroughly, and tilt them carefully into rods, an article has been produced, which possesses all the requisites of fine steel in an eminent degree. In the supplement to the Encyclopædia Britannica, article *Cutlery*, the late Mr. Stodart, of the Strand, a very competent judge, has declared "that for the purposes of fine cutlery, it is infinitely superior to the best English cast steel."

The natives prepare the cakes for being drawn into bars, by annealing them for several hours in a small charcoal furnace, actuated by bellows; the current of air being made to play upon the cakes while turned over before it; whereby a portion of the combined carbon is probably dissipated, and the steel is softened; without which operation the cakes would break in the attempt to draw them. They are drawn by a hammer of a few pounds weight.

The natives weld two pieces of cast steel, by giving to each a sloping face, jagged all over with a small chisel; then applying them with some calcined borax between, and tying them together with a wire, they are brought to a full red heat, and united by a few smart blows of a hammer.

The ordinary bar iron of Sweden and England, when converted by cementation, into steel, exhibits upon its surface numerous small warty points, but few or no distinct vesicular eruptions; whereas the Dannemora and the Ulverston steels present, all over the surface of the bars, well raised blisters, upwards of three-eighths of an inch in diameter, horizontally, but somewhat flattened at top. Iron of an inferior description, when highly converted in the cementing-chest, becomes grey on the outer edges of the fracture; while that of Dannemora acquires a silvery color and lustre on the edges, with crystalline facets within. The highly converted steel is used for tools that require to be made very hard; the slightly converted, for softer and more elastic articles, such as springs and sword blades.

VENEERING.*

Veneering is the method of covering an inferior wood with a surface of a very superior kind, so that the parts of the article of furniture thus manufactured which meet the eye, appear to the same advantage as if the whole work were of the best description. If this be well performed, it is very durable, looks well to the last, and is attainable at an expense considerably less than a similar article would cost if manufactured of the same wood throughout, but of an inferior quality.

The principal requisite to ensure success in veneering, is to select well-seasoned wood for the ground, to use the best and strongest glue. Be careful to exclude the air in gluing on your veneer, or a blister will arise, and spoil your work in that part. We need not add any more to these remarks, as the following process contains the most essential directions necessary.

Common Veneering.—It is a desideratum among workmen to veneer their work in such a manner that it will stand. Several of the methods commonly used cause the piece either to warp in winding, or otherwise to get hollow, after the work is finished, on its upper-side; and however careful the workman may be in laying his veneer, this will sometimes happen; much depends upon the manner of preparing the ground, perhaps more than in that of laying the veneer. Select that piece of deal which is freest from knots, slip it down the middle, or, take a piece out of the heart, and place the board when cut to the required length in a warm place for two or three days; then joint them up, placing a heart edge and an outside edge together; when dry, cut your top again between each joint, and joint it afresh; you will then have a top glued up of pieces about two inches wide, and if you have been careful in making your joints good, you will have a top not so liable to cast after it is veneered, as many of the tops which are now done by the methods usually in practice.

You may use wainscot or other wood, instead of deal, but make your joints in the same manner. It is also a good plan, after having veneered your top, to lay it on the ground on some shavings, with the veneer downwards; it then dries gradually, and is much less likely to cast than by drying too quick.

To Raise Old Veneers.—In repairing old cabinets, and other furniture, workmen are sometimes at a loss to know how to get rid of those blisters which appear on the surface, in consequence of the glue under the veneer failing or causing the veneer to separate from the ground in patches; and these blisters are frequently so situated, that, without separating the whole veneer from the ground, it is impossible to introduce any glue between them to relay it; the great difficulty in this case is to separate the veneer from the ground without injuring it, as it adheres in many places too fast to separate without breaking it. We will here, therefore, show how this operation may be performed without difficulty, and the veneer preserved perfectly whole and uninjured, ready for relaying as a new piece. First wash the surface with boiling water, and with a coarse cloth remove dirt or grease; then place it before the fire, or heat it with a caul; oil its surface with common linseed oil, place it again to the fire, and the heat will make the oil penetrate quite through the veneer and soften the glue underneath; then whilst hot raise the edge gently with a chisel, and it will separate completely from the ground: be careful not to use too great force, or you will spoil your work; again, if it should get cold during the operation, apply more oil, and heat it again: repeat this process till you have entirely separated the veneer; then wash off the old glue, and proceed to lay it again as a new veneer.

Glue for Inlaying and Veneering.—The best glue is readily known by its transparency, and being of a light brown, free from clouds and streaks. Dissolve this in water, and to every pint add half a gill of the best vinegar and half an ounce of isinglass.

To Veneer Tortoiseshell.—First observe to have your shell of an equal thickness, and scrape and clean the underside very smooth; grind some vermillion very fine, and mix it up with spirits of turpentine and varnish; lay two or three coats of color on the under side of the shell, till it becomes opaque; when dry, lay it down with good glue.

Laying the Veneer.—Having made your work perfectly level with a tooth-plane apply to your veneer the glue, and lay it on your work; then with a hot board, termed a caul, fasten it down by means of hand-screws, and let it remain till perfectly hard. It then only remains to be cleaned off and polished, according to the following directions.

In order to add to the beauty of your work, and produce a variety in the shade, it is necessary, before laying on veneer, to give that side intended to be glued a coat or two of some color ground in oil or varnish, and set it to dry thoroughly before you lay your veneer, as red lead and vermillion ground together; king's yellow, Prussian blue, or any color you may fancy; and sometimes the surface is gilt on the side which you intend to lay on your work; this produces a very brilliant effect, and even common Dutch metal applied will have a very good effect.

The method here given for tortoiseshell is equally applicable to woods of two different colors, only then you need not use any other glue but that in common use, which must be good.

CHEMICAL TESTS.

(Resumed from page 328.)

Tests for Lead, Arsenic, and Chalk, when White Oxide of Zinc is supposed to be adulterated by them.—The two first of these adulterations may be accidental: the latter is wilfully done for fraudulent purposes. To detect the arsenic and lead, put some of the suspected powder into a tumbler, and pour over it pure acetous acid, (distilled vinegar) decant the solution into another tumbler, and pour in some Harrowgate water. If lead be present, the sulphuretted hydrogen of this test will turn it black, and a precipitate of that color will accordingly fall down. If arsenic be contained in it, the precipitate will be yellow. In case that both these should be present, it will be proper to examine the precipitate after decantation of the supernatant liquid. To discover the presence of chalk;—when acetous acid is poured over it, an effervescence of carbonic acid gas will take place; but as a farther proof, add a solution of oxalic acid to the acetous solution: an insoluble white precipitate of oxalate of lime will instantly fall down.

Sulphurous Acid Gas a Test for Water held in Solution in the Atmosphere.—Sulphurous acid gas received over mercury is an invisible aerial body; but if a phial containing this gas be opened, an immediate cloud of vapour will be seen hovering over it. This is caused by the ascent of the gas, and the great affinity it has for moisture: this it finds in the air, in the state of vapour from water, and with this vapour it immediately combines, forming a dense cloud.

Muriate of Tin a Test for Tanning.—As it is of importance in many cases to ascertain the existence of tannin, or the astringent principle in vegetable infusions, the following may be depended on as a delicate test. Pour a few drops of the solution of muriate of tin into a wine glass containing an infusion of gall-nuts, or of Peruvian or oak bark. This salt will form an insoluble precipitate with the tannin contained in each of these.

Gelatine and Tannin Tests for each other.—When tannin is suspected to exist in any vegetable make a decoction or infusion of it; and into half a wine glass full, drop some solution of isinglass, size, glue, or animal gelatine, obtained by boiling calves feet, &c. If tannin exists in the infusion or decoction, a white or yellowish flocculent precipitate will instantly take place. The most ready experiment of this kind will be to add a few drops of the solution of size to an infusion of galls, oak bark, or Peruvian bark, when the effect will be satisfactory. On the other hand, an infusion of galls or oak bark will discover the presence of gelatine, in mixture where it may exist. In all effects of this kind, the tannin by its astringent power, brings the gelatinous particles in a closer contact, and thus coagulating, they are precipitated. It is on this principle that leather is tanned, the raw hides contain gelatine, and the oak bark tannin; and when the hides are immersed in pits containing the bark liquor, their fibres are brought in closer contact, and of course their texture is thus rendered tougher and stronger.

Iodine and Starch, Tests for Arsenic, and Corrosive Sublimate.—The following method has been proposed by Arugnatelli, for discovering arsenic and corrosive sublimate in their respective solutions, and to distinguish them from each other. We

must take the starch of wheat boiled in water, until it is of a proper consistence, (and recently prepared ;) to this is to be added a sufficient quantity of iodine until it is of a blue color ; it is afterwards to be diluted with pure water, until it becomes of a beautiful azure blue. — If to this azure colored solution of starch we add some drops of an aqueous solution of the oxide of arsenic, the color changes to a redish hue, and finally is quite dissipated. The solution of corrosive sublimate, poured into the iodine and starch, produces in it almost the same change with the arsenic ; but if, to the fluid, discolored by the oxide of arsenic, we add some drops of sulphuric acid, the original blue color is restored with more than its original brilliancy ; whilst the color of the fluid that has been discharged, by the corrosive sublimate, cannot be restored, either by the sulphuric acid, or by any other means.

Tests to detect Chlorate of Mercury.—Expose the suspected substance to heat, in a tube, but without any carbonaceous mixture, the corrosive sublimate will rise in fumes and line the interior surface of the tube with a shining white crust. This crust is then to be dissolved in distilled water, and assayed by the following tests :—First, lime-water will produce a precipitate of an orange yellow color. Second, a single drop of a dilute solution of sub-carbonate of potass, will, at first, produce a white precipitate, but on a still further addition of the test, an orange-colored sediment will be formed. Thirdly, water holding in solution sulphuretted hydrogen, will throw down a dark colored precipitate, which when dried, and strongly heated, may be volatilized without any odour of garlic being manifested.

Much difficulty has often been experienced in detecting the mineral substances which act as poisons, especially corrosive sublimate, arsenic, copper, lead, and bismuth ; when they have been mingled, in the stomach, with colored liquids, such as red wine and coffee, a circumstance which not unfrequently happens in cases of poisoning by those minerals. This difficulty has arisen from the color of red wine or coffee, changing that of the precipitates obtained by the tests above designated. A method was discovered by Orfila, by which these inconveniences may be obviated. The process consists in first discoloring or bleaching the liquid to be examined, by means of a concentrated solution of chlorine in water (strong oxy-muriatic or chloric acid,) then applying the proper tests in the ordinary way. As the solution of chlorine decomposes but a very few of the mineral poisons, there are hardly any of them to which this method is not applicable. Nitrâte of silver and tartarized antimony are the only exceptions likely to occur in medical practice.

We shall here detail some further experiments to elucidate more clearly this important subject. Some white oxide of arsenic was dissolved in water and mingled with red wine, a sufficient quantity of a concentrated solution of chlorine was added to change the mixture to a yellow color ; a yellowish-red precipitate formed, composed of chlorine and the glutinous matter contained in the wine ; when this precipitate had settled, the liquor was filtered ; in this, lime-water produced a white, ammoniacal sulphate of copper a green, and sulphuric acid a yellow precipitate. The same results were obtained from a mixture of coffee with white arsenic. Corrosive sublimate treated in the same way, was precipitated of a yellow color by potass, white by liquid ammonia, and black by sulphuretted hydrogen. Sulphate of copper and verdigris, submitted to the same process, furnished a brownish precipitate with the prussiate of potass, green with the arseniate of potass, and black with the hydrosulphurets. Litharge and acetate of lead, treated in a similar way, gave rise to white precipitates with the sulphate of potass, black with the hydrosulphurets, and bright yellow with the chromate of potass. If some of the foregoing mixtures are too much diluted when the tests are applied, no precipitates will be produced ; it will, in some cases, be necessary to evaporate them previously to the addition of the chlorine to one-half or one-quarter, or less, of their volume; when the desired effects will be produced.

To determine whether a Mineral contains Lead.—Break a small portion from the ore, and observe the fragments and their brilliancy ; now place a bit not larger than a pepper-corn on a piece of charcoal, then with the blow-pipe, blow through the flame of a candle, directing the jet upon the mineral. If it contains lead, it will instantly discharge sulphureous vapours, and in half a minute, the lead will be reduced.

The ores of this metal are numerous ; the most common is blue lead ore, which occurs in great quantity, and from it the lead in commerce is produced. Others are of various colors, as grey, green, brown, yellow and red.

To detect Mercury in Minerals.—Earths or minerals of any kind, containing mercury, are most accurately assayed by distilling them with iron-filings ; but whether a mineral contains mercury or not, may be easily discovered, by strewing it, when powdered, on a plate of hot iron, or on a hot brick covered with iron-filings, and inverting over it a glass of any kind ; the mercury, if the mineral contains any, will ascend, and attach itself in small globules to the sides of the glass.

Mercury is found both in the native state, and as an ore, combined with sulphur, &c. Native mercury is called living or running mercury, because it is seen to run in small streams at the bottoms of some mines. It is more frequently, however, imbedded in calcareous earths, or clays of different colors, from which it may be separated either by trituration and lotion, (the smaller globules coalescing by mutual contact into larger ;) or by distillation. Cinnabar is the most common ore of mercury ; it is found in an earthy form, resembling red ochre, sometimes in an indurated state, and, though generally red, it has been observed of a yellowish or blackish cast ; it is mostly opaque, but some pieces are as transparent as a ruby. This ore consists of mercury and sulphur combined together in different proportions ; some cinnabars yielding as much as seven, others not three parts, in eight, of their weight of mercury. Sulphur and mercury, being both volatile in a small degree of heat, would rise together in distillation, unless some substance, such as quick-lime or iron-filings, was added to the cinnabar, which by superior affinity, can unite itself with, and detain the sulphur : whilst the mercury, not being able to support the heat, is elevated in vapour, and condensed in various ways in different works.

(To be continued.)

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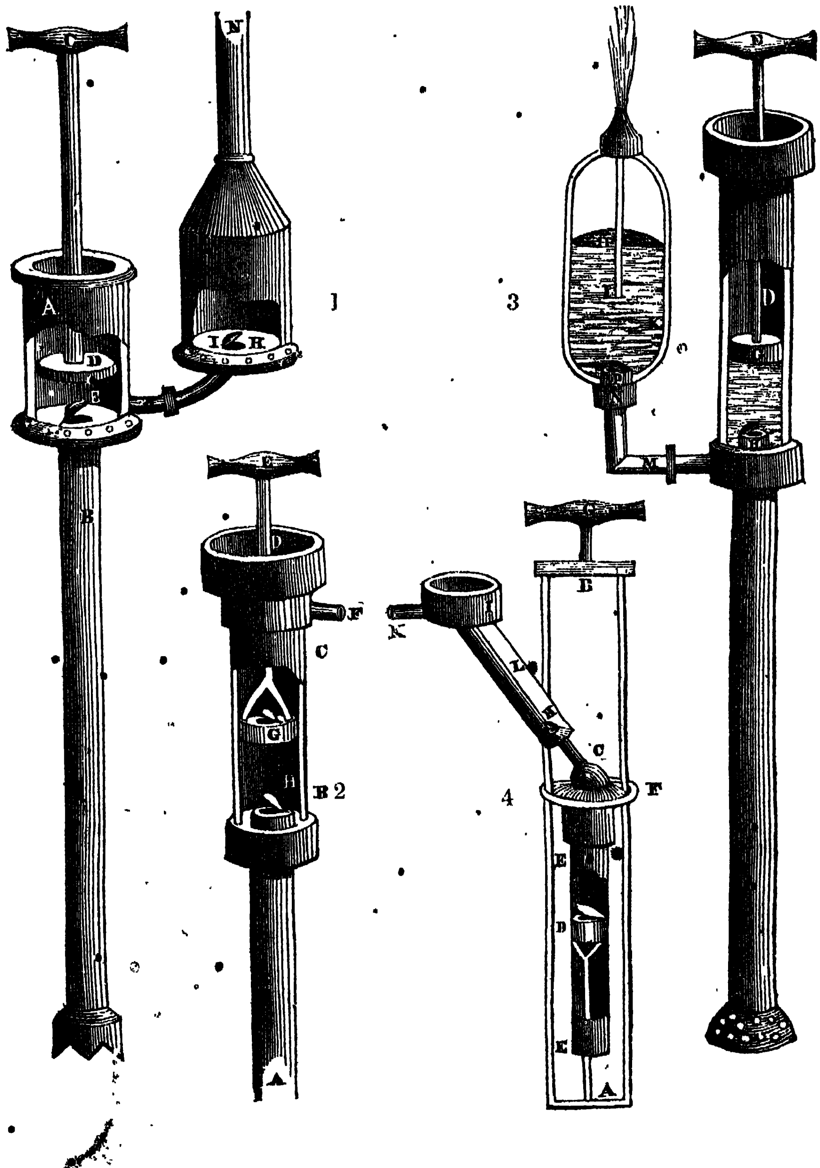

HYDRAULIC ENGINES.—PUMPS

HYDRAULIC ENGINES.—PUMPS.

PUMPS are of general utility, and have such a variety of forms and principles of construction, that a few words on the more valuable of them will not be useless or uninteresting. Pumps act either by the pressure of the atmostphere, when the explanation of their mode of action depends upon pneumatics. Some act upon the property that water, as will as other fluids, transmits the mechanical impulse it receives; or upon other laws relative to fluid pressure, momentum, &c., when we must call in the aid hydraulics for their elucidation. Besides these, are various machines for raising water, dependent purely upon mechanical principles, upon centrifugal force, &c., independent of the laws of fluid motion.

It is proposed, at present, to consider only some of the more useful instruments of the first kind, or those dependent chiefly on the pressure of the air. These are divided into the *common* pump, the *force* pump, and the *lift* pump; before, however, these are explained, it will be right to consider one still more ancient then either of them, and that pump which was known to, and used by, the ancients, and which was invented by *Ctesibius.*

Ctesibius Pump, the first of all the kinds, acts both by suction and pulsion, the water being drawn up at one part of the instrument, and pushed up at another; its structure and action is as follows; A cylinder, A, Fig. 1, forms the pump barrel; it is furnished with a valve at E, and has a pipe B, which proceeds to the well below. In the pump barrel is a piston, D, made of green wood, which will not swell in the water, and adjusted to the aperture of the cylinder, with a covering of leather, but without any valve. There is a second pipe on the side of A, which proceeds to another vessel, H, and has at the end of it a valve, I. When the piston is raised by the handle, the water opens the valve, E, and rises into the cavity of the cylinder, and when the same piston is again depressed, the valve, I, is opened, and the water driven up the tube, N.

The Common Sucking Pump.—To understand the action of the common pump, suppose a model like that of Fig. 2 be put into a bucket of water, the water being deep enough to cover the lower part of the pipe, A; the valve on the moveable bucket, G, and the valve on the fixed box, H, which box quite fills the cavity of the barrel, B C, will lie close by its own weight upon the hole in the bucket and box, until the engine begins to work; the sucker, or bucket, G, is raised or depressed by the handle, E; the bucket being supposed at the lower part of the barrel when the working begins; take hold of the handle, E, and thereby draw up the bucket from B to C, which will make room for the air in the pump, all the way below the bucket to dilate itself, by which its spring is weakened, and then its force is not equivalent to the weight or pressure of the outward air upon the water in the vessel below; and, therefore, at the first stroke the outward air will press up the water into the lower pipe, and after a stroke or two, will penetrate through the valve, H, and occupy the cylinder or barrel, B C. Upon depressing the bucket again, the water cannot return, because any force applied above will necessarily close the valve, H, and the bucket in returning will press upon the water, until the pressure of the water upon the under surface of the valve in G, will open the valve at that part, and escaping through the hole, will occupy a space above the bucket G. The next stroke of the handle will have a double effect, it will draw up the water from the well, as in the former instance, so that it shall again fill the cylinder, but with fresh water; for it will be readily seen, that the lifting of the bucket after the water has obtained access, above it, does not replace that water as before, but the very circumstance of lifting the handle will close the valve above, and the water will be lifted up at the same time; were there no appointed outlet for the lifted water, it would flow over the top of the barrel, but to remedy the inconvenience of this, a spout is usually attached, through which the water raised, by one stroke after another, is carried away.

As it is the pressure of the atmosphere which causes the water to rise, and follow the piston, or bucket, G, as it is drawn up; and since a column 32 feet high is of equal weight with as thick a column of the atmosphere from the earth to the very top of the air, therefore, the perpendicular height of the piston, or bucket, from the surface of the water in the well must always be less than 32 feet, otherwise the water will never get above the bucket. But when the height is less, and the water has once got above the bucket, it may be lifted to any height, if the pipe which conveys it away be made long enough, and a sufficient degree of strength be employed to raise it with the weight of the water above without even lengthening the stroke.

The Force Pump is represented in Fig. 3. A is the pipe from the well; B C, the pump barrel; D, the plunger, which is a solid piston, and E, the handle; K is the air vessel, or condenser; I, the lower part of the jet, or eduction pipe; M, a pipe of communication between the pump barrel and condenser; the mode of action is very simple: when the plunger is drawn up, the pressure of the atmosphere upon the surface of the water in the well, forces it up the pipe, A, through the box and valve, H, filling the space below the piston or plunger; when this is forced down, the valve, H, closes, and the water is driven through the pipe, M, and the valve, P, opening, admits the water above into the vessel, K. The water being thus forced into the air-vessel, K, by repeated strokes of the plunger, gets above the lower end of the pipe, I, and then begins to condense the air in the upper part of the vessel, K; for as the pipe, I, is fixed air tight into the vessel below F, and the air has no way to get out of the vessel but through the pipe, I, and cannot get out when the mouth, I, is covered with water, and is more and more condensed as the water rises up the pipe, the air begins to act forcibly by its spring against the surface of the water at H, and this action drives the water up through the pipe, I, from whence it spouts in a jet to a great height, and is supplied by alternately raising and depressing the handle, E, and as the spring of the air continues while the plunger is being raised, the stream, or jet, will be uniform as long as the pumping action continues. If there were no air vessel, the pipe, I, would be joined to N, and then the jet of water would stop every time the plunger is raised

The Lifting Pump, represented in Fig. 4, differs from the sucking pump only in the disposition of its valves, and the form of its piston frame,

E E is a barrel fixed in a rectangular frame, A B; the barrel is a fixture, and has its lower end in the water; the frame is moveable up and down; it is

attached below to a cross bar, which bears the handle; D is an inverted piston, with a valve as represented. Upon the top of the barrel is a sloping part, L, either fixed to the barrel, or with a ball and socket joint, in either case air and water tight; in this part, at H, is a valve that opens upwards. It is evident, that when the piston frame is thrust down into the water, the piston, D, descends, and the water below will rush up through the valve, D, and get above the piston, and that when the frame is lifted up, the piston will force the water through the valve, C, up into the cistern, I, there to run off by the spout, K. The piston of this pump plays below the surface of the water.

OF GILDING THE BORDERS OF GLASS.

The art of gilding upon glass, which is a revival and improvement upon attempts made many years ago, is chiefly used for decorating the borders of prints, in executing name plates and inscriptions for various purposes, as also for ornamental decorations in a variety of elegant works, with different colored grounds; but, as black is the most general one in demand, we shall first proceed to treat on that, in two ways of performing it.

You are to procure some of the finest isinglass, which you will distinguish by holding it between you and the light, when that which is white and transparent is the best, and the contrary is totally unfit for this purpose. Dissolve it in very clean water, pretty thick, and strain it through a linen cloth; then, into a tea cup of very clean milk-warm water, put about the size of a small pea of the isinglass jelly, which let gently incorporate with the water; now, having your glass that is to be gilt quite clear, and free from any dirt or grease, get some leaf gold, the less porous in the beating the better, put it on a gilding cushion, and cut it in pieces for your purpose, according to the breadth required; then touch, with a hair pencil dipped in the thin isinglass water, on the glass; and, while moist, lay on your leaf gold, piece by piece, until you have the parts you want covered. The leaf will instantly adhere to the glass; then place it within the air of a fire, in a slanting position, until it dries, which will be in a few minutes. While it is gently warm, take a piece of clean cotton wool, and rub the gold to the glass smartly, until you not only find the superfluous pieces of leaf gold gone, but that likewise the back of the part gilt receives a kind of polish; then proceed to lay on a second coat of gold, in the same manner as the first, drying it as before, and polishing it; and so a third coat, which is full sufficient, and, to gild properly, cannot be dispensed with. Then take the size of the print or drawing, which is to be framed, and laying it on the gilt parts of the glass, mark where the corners are to come, with a hair pencil, and some dark color; after which, being provided with a long wooden ruler, and a pointed piece of ivory, draw parallel lines out of your gold, and with a mahogany or deal stick, pointed cautiously, work away the superfluous part, leaving the gold fillet which is to encompass your picture, sharp and neat; when, if you have a mind to ornament it by any other lines to appear black, in the centre, lay on your ruler, and with your ivory point scribe them, and then varnish, having some black japan, to which a little burnt lamp black has been added, to deepen its color. Paint it all over the gilt part of your glass, and the space between it and the edge, then set it to dry, which will take place in a few hours, when you are to lay out the breadth of the black line that is to be inside your gilding, scribe it with a sharp point, and cut away the waste black, with a graver or some sharp instrument.

If you want to cut figures, or any kind of ornament, out of your gold, after your glass is gilt, have a drawing of your design on paper, at the back of which rub some powdered red chalk, and the smallest quantity of fresh butter; lay the paper on the gold, and, with a bluntish ivory point, go over the lines of the drawing, and they will be nicely transferred on the gold; when you can, with an ivory point, trace them out of the gold, and shade them agreeably to either fancy, or from the drawing you have by you; and then, by mixing any color you choose with white copal varnish, you may vary your ground as you think proper.

But the most important secret in the glass gilding, is the method which only a few persons in London are acquainted with. In an instant after your glass is blacked, take away the parts where your gold is to appear, and leave the remainder of the black to stand fast, by which means the black gilding work is done in one half the time, and with half the gold leaf. The process is simple, and is thus performed:—You are to get the very best black japan varnish, such as is used for the roofs of carriages, to which you may add a very small share of burned lamp black, very finely ground in spirits of turpentine; then, with a large flat varnish brush, give your glass one even thin coat, holding it between you and the light, observing that it does not appear a thick dead black, but exhibits a degree of transparency, and not too much so as to prevent its appearing a good black at the right side of the glass. After this, you are to have your letters or ornaments, drawn on paper as before mentioned, and trace it in the same manner on your black varnish, when it is perfectly dry; the drawing will be very critically transferred to the black. You are then to get a fine needle, and fix it in a wooden handle, firmly, with which you are to scribe the outlines of what black is to come out, through the varnish, so as not an edge hangs to the main body of the black. Then take some thick brown paper, dip it in water, and squeeze it gently, and spread it over the parts of the varnish you want to detach from the glass, and in a few minutes, by raising one edge of the black, it will all peel away as clean from the glass as if it never was on it, in an instant. When all the black you want is taken out, lay your glass to the fire, and the remaining part of the varnish will instantly become hard as ever, and ready to have the gold put on.

MARBLE.

This title embraces such of the primitive, transition, and purer compact limestones of secondary formation, as may be quarried in solid blocks without fissures, and are susceptible of a fine polished surface. The finer, the white, or more beautifully variegated the colors of the stone, the more valuable, *ceteris paribus*, is the marble. Its general characters are the following:—

Marble effervesces with acids; affords quicklime by calcination; has a conchoidal scaly fracture; is translucent only on the very edges; is easily scratched by the knife; has a spec. grav. of 2·7; admits of being sawn into slabs; and receives a brilliant polish. These qualities occur united in only three principal varieties of limestone; in the

saccharoid limestone, so called from its fine granular texture, resembling that of loaf sugar, and which constitutes modern statuary marble, like that of Carrara; 2. in the foliated limestone, consisting of a multitude of small facets, formed of little plates applied to one another in every possible direction, constituting the antique statuary marble, like that of Paros; 3. in many of the transition and carboniferous, or *encrinitic* limestones, subordinate to the coal formation.

The saccharoid and lameller, or statuary marbles, belong entirely to primitive and transition districts. The greater part of the close-grained colored marbles belong also to the same geological localities; and become so rare in the secondary limestone formations, that immense tracts of these occur without a single bed sufficiently entire and compact to constitute a workable marble. The limestone lying between the calcareo-siliceous sands and gritstone of the under oolite, and which is called Forest marble in England, being susceptible of a tolerable polish, and variegated with imbedded shells, has sometimes being worked into ornamental slabs in Oxfordshire, where it occurs in the neighbourhood of Whichwood forest; but this case can hardly be considered as an exception to the general rule. To constitute a profitable marble-quarry, there must be a large extent of homogeneous limestone, and a facility of transporting the blocks after they are dug. On examining these natural advantages of the beds of Carrara marble, we may readily understand how the statuary marbles discovered in the Pyrenees, Savoy, Corsica, &c., have never been able to come into competition with it in the market. In fact, the two sides of the valley of Carrara may be regarded as mountains of statuary marble of the finest quality.

Gypseous alabaster may be readily distinguished from marbles, because it does not effervesce with acids, and is soft enough to be scratched by the nail; stalagmitic alabaster is somewhat harder than marble, translucent, and variegated with regular stripes or undulations.

Some granular marbles are flexible in thin slabs, or, at least, become so by being dri[illegible] at the fire; which shows, as Dolomieu suspected, that this property arises from a diminution of the attractive force among the particles, by the loss of the moisture.

The various tints of ornamental marbles generally proceed from oxides of iron; but the blue and green tints are sometimes caused by minute particles of hornblende, as in the slate-blue variety, called Turchino, and in some green marbles of Germany. The black marbles are colored by charcoal, mixed occasionally with sulphur and bitumen; when they constitute stinkstone.

Brand divides marbles, according to their localities, into classes, each of which contains eight subdivisions:—

1.—Uni-colored marbles; including only the white and the black.

2.—Variegated marbles; those with irregular spots or veins.

3.—Madreporic marbles, presenting animal remains in the shape of white or grey spots, with regularly disposed dots and stars in the centre.

4.—Shell marbles; with only a few shells interspersed in the calcareous base.

5.—Lumachella marbles, entirely composed of shells.

6.—Cipolin marbles, containing veins of greenish talc.

7.—Breccia marbles, formed of a number of angular fragments of different marbles, united by a common cement.

8.—Puddingstone marbles; a conglomerate of rounded pieces.

Antique marbles.—The most remarkable of these are the following:—*Parian marble*, called *lychnites* by the ancients, because its quarries were worked by lamps; it has a yellowish-white color; and a texture composed of fine shining scales, lying in all directions. The celebrated Arundelian tables at Oxford consist of Parian marble, as well as the Medicean Venus. *Pentelic marble*, from Mount Penteles, near Athens, resembles the Parian, but is somewhat denser and finer grained, with occasional greenish zones, produced by greenish talc, whence it is called by the Italians *Cipolino statuario*. The Parthenon, Propyleum, the Hippodrome, and other principal monuments of Athens, were of Pentelic marble; of which fine specimens may be seen among the Elgin collection, in the British Museum. *Marmo Greco*, or Greek white marble, is of a very lively snow white color, rather harder than the preceding, and susceptible of a very fine polish. It was obtained from several islands of the Archipelago, as Scio, Samos, Lesbos, &c. *Translucent white marble*, *Marmo statuario* of the Italians, is very much like the Parian, only not so opaque. Columns and altars of this marble exist in Venice, and several towns of Lombardy; but the quarries are quite unknown. *Flexible white marble*, of which five or six tables are preserved in the house of Prince Borghese, at Rome. The *White marble of Luni*, on the coast of Tuscany, was preferred by the Greek sculptors, to both the Parian and Pentelic. *White marble of Carrara*, betwen Specia and Lucca, is of a fine white color, but often traversed by grey veins, so that it is difficult to procure moderately large pieces free from them. It is not so apt to turn yellow as the Parian marble. This quarry was worked by the ancients, having been opened in the time of Julius Cæsar. Many antique statues remain of this marble. Its two principal quarries at the present day are those of Pianello and Polvazzo. In the centre of its blocks very limpid rock-crystals are sometimes found, which are called Carrara diamonds. As the finest qualities are becoming excessively rare, it has risen in price to about three guineas the cubic foot. The *White marble* of Mount Hymettus, in Greece, was not of a very pure white, but inclined a little to grey. The statue of Meleager, in the French Museum, is of this marble.

Black antique marble, the *Nero antico* of the Italians. This is more intensely black than any of our modern marbles; it is extremely scarce, occurring only in sculptured pieces. The *red antique marble*, *Egyptum* of the ancients, and *Rosso antico* of the Italians, is a beautiful marble of a deep blood red color, interspersed with white veins and with very minute white dots, as if strewed over with grains of sand. There is in the Grimani palace at Venice, a colossal statue of Marcus Agrippa in *rosso antico*, which was formerly preserved in the Pantheon at Rome. *Green antique marble*, *verde antico*, is a kind of breccia, whose paste is a mixture of talc and limestone, while the dark green fragments consist of serpentine. Very beautiful specimens of it are preserved at Parma. The best quality has a grass-green paste, with black spots of noble serpentine, but is never mingled with red spots. *Red spotted green antique marble*, has a dark green

ground marked with small red and black spots, with fragments of *entrochi* changed into white marble. It is known only in small tablets. *Leek marble;* a rare variety of that color, of which there is a table in the Mint at Paris. *Marmo verde pagliocco* is of a yellowish green color, and is found only in the ruins of ancient Rome. *Cervetas marble* of a deep red, with numerous grey and white veins, is said to be found in Africa, and highly esteemed in commerce. *Yellow antique marble, giallo antico* of the Italians; color of the yolk of an egg, either uniform or marked with black or deep yellow rings. It is rare, but may be replaced by Sienna marble. *Red and white antique marbles,* found only among the ruins of ancient Rome. *Grand antique,* a breccia marble, containing shells, consists of large fragments of a black marble, traversed by veins or lines of a shining white. There are four columns of it in the Museum at Paris. *Antique Cipolino marble.* Cipolin is a name given to all such marbles as have greenish zones produced by green talc; their fracture is granular and shining, and displays here and there plates of talc. *Pursle antique breccia marble* is very variable in the color and size of its spots. *Antique African breccia,* has a black ground, variegated with large fragments of a greyish-white, deep red, or purplish wine color: and is one of the most beautiful marbles. *Rose colored antique breccia marble* is very scarce, occurring only in small tablets. There are various other kinds of ancient breccias, which it would be tedious to particularize.

(To be continued.)

PAPIN'S DIGESTER.

Papin's digester is a vessel, by means of which a degree of heat is communicated to water, superior to that which it acquires when it boils. Water indeed exposed to common air, or the mere pressure of the atmosphere, however strongly it boil, can acquire only a certain degree of heat, which never varies; but that inclosed in Papin's digester acquires such a degree, that it is capable of performing operations, for which common boiling water is absolutely insufficient. A proof of this will be seen in the description of the effects produced by this machine.

This vessel may be of any form, though the cylindric or spherical is best; but it must be made of copper or brass. A cover must be adapted to it, in such a manner as to leave no aperture through which the water can escape. To prevent the vessel from bursting, a hole is made in the side of it, or in the cover, some lines in diameter, with an ascending tube fitted into it, on which is placed the arm of the lever kept down by a weight. This lever serves as a moderator to the heat; for if there were no weight on the aperture of this regulator, the water, when it attains to a certain degree of ebullition, would escape almost entirely through the aperture, either in water or in steam: if the weight be light, the water, in order to raise it, must assume a greater degree of heat. If there were no regulator of this kind, the machine might burst into pieces, by the expansive force of the steam. For this reason, it is proper that the machine should be of ductile copper, and not of cast iron; because the former of these metals does not burst like the latter, but tears as it were; so that it is not attended with the same dangerous consequences.

When the machine is thus constructed, fill it with water, and having fitted on the cover, let it be fastened strongly down by a piece of iron placed over it, which can be well secured by screws: then complete the filling it through the small tube which serves as a moderator or register, and set it over a strong fire. The water it contains cannot boil; but it acquires such a degree of heat that it is able, in a short time, to soften and decompose the hardest bodies; while the same effect could not be produced by ebullition continued for several weeks: it is even said that the heat may be carried so far, as to bring the machine to a state of incandescence; in which case it is evident that the water must be in the same; but this exoeriment is exceedingly dangerous.

However, the following are some of the effects of this heat, when carried only to three, four, or five times that of boiling water.

Horn, ivory, and tortoise-shell, are softened in a short time, and at length reduced to a sort of jelly.

The hardest bones, such as the thigh bone of an ox, are also softened, and at length entirely decomposed; so that the gelatinous part is separated from them, and the residuum is nothing but earthy matter. When no more than the proper degree of heat has been employed in this decomposition, the jelly may be collected: it coagulates as it cools, and may be made into nourishing soup, which would be equal to that commonly used, if it had not a taste somewhat empyreumatic. This jelly may be absolutely formed into dried cakes, which will keep exceedingly well, provided they be preserved from moisture. They may serve as a substitute for meat soup, &c.

Hence it may be conceived, how useful this machine might be rendered in the arts, for economy, and in navigation.

From these bones, thrown away as useless, food might be obtained for the poor in times of scarcity, or some ounces of bread, with soup made from the above cakes, would form wholesome and nourishing aliment.

Sailors might carry with them, during their long voyages, some of these cakes, preserved in jars hermetically sealed; they would cost much less than preparations of the same kind from meat, as the matter of which the former are made is of no value. The sailors, who are accustomed to live on salt provisions, would be less exposed to the scurvy. At any rate, these cakes might be reserved till a scarcity of fresh meat or of any kind of provisions, which so often takes place at sea. It would be a great advantage to have collected into a small volume the nourishing part of several oxen; for since a pound of meat contains, at least, an ounce of gelatinous matter reduced to dryness, it thence follows that 1500 pounds of the same meat, which is the whole weight of a bullock, would give only 92 pounds, which might be easily contained in an earthen jar.

In the last place, it would be of great use to the arts, to be able, with a machine of this kind, to soften ivory, horn, bone, and wood, so as to render them susceptible of being moulded into any form at pleasure.

PRODIGIOUS FORCE OF MOISTURE TO RAISE BURDENS.

One of the most singular phenomena in physics, is the force with which the vapour of water, or moisture, penetrates into those bodies which are susceptible of receiving it. If a very considerable burden

be affixed to a dry and well-stretched rope, and if the rope be only of such a length as to suffer the burden to rest on the ground, on moistening the rope you will see the burden raised up.

The anecdote respecting the famous obelisk erected by Pope Sixtus V., before St. Peter's, at Rome, is well known. The Chevalier Fontana, who had undertaken to raise this monument, was, it is said, on the point of failing in his operation, just when the column was about to be placed on its pedestal. It was suspended in the open air; and as the ropes had stretched a little, so that the base of the obelisk could not reach the summit of the pedestal, a Frenchman cried out "wet the ropes." This advice was followed; and the column, as if of itself, rose to the necessary height, to be placed upright on the pedestal prepared for it.

This story, however, though often repeated, is a mere fable. Those who read the description of the manœuvres which Fontana employed to raise his obelisk, will see that he had no need of such assistance. It was much easier to cause his capstans to make a few turns more than to go in quest of sponges and water to moisten his ropes. But the story is established, and will long be repeated in France, because it relates to a Frenchman.

However, the following is another instance of the power of moisture, in overcoming the greatest resistances: it is the method by which millstones are made. When a mass of this stone has been found sufficiently large, it is cut into the form of a cylinder, several feet in height; and the question then is, how to cut it into horizontal pieces, to make as many millstones. For this purpose, circular and horizontal indentations are cut out quite around it, and at proper distances, according to the thickness to be given to the millstones. Wedges of willow, dried in an oven, are then driven into the indentations by means of a mallet. When the wedges have sunk to a proper depth, they are moistened, or exposed to the humidity of the night, and next morning the different pieces are found separated from each other. Such is the process which, according to M. de Mairan, is employed in different places for constructing millstones.

By what mechanism is this effect produced? This question has been proposed by M. de Mairan; but in our opinion, the answer which he gives to it is very unsatisfactory. It appears to be the effect of the attraction by which the water is made to rise in the exceedingly narrow capillary tubes with which the wood is filled. Let us suppose the diameter of one of these tubes to be only the hundreth part of a line; let us suppose also that the inclination of the sides is one second, and that the force with which the water tends to introduce itself into the tube, is the fourth part of a grain: this force, so very small, will tend to separate the flexible sides of the tube, with a force of about 50000 grains; which make about 8¾ pounds. In the length of an inch let there be only 50 of these tubes, which gives 2500 in a square inch, and the result will be an effort of 21875 pounds. As the head of a wedge, of the kind above mentioned, may contain four or five square inches, the force it exerts will be equal to to about 90 or 100,000 pounds; and if we suppose 10 of these wedges in the whole circumference of the cylinder, intended to form millstones, they will exercise together an effect of 1·000·000 or a million of pounds. It needs, therefore, excite no surprise that they should separate those blocks into the intervals between which they are now introduced.

COAL-FINDING.

In the mysterious business of coal-finding, we are warranted in making any reasonable experiments which may lead to a recovery of the range of the whole series of coal measures, and in drawing inferences for our guidance in the choice of places of trial, from the most remote phenomena which seem to favour our purpose; for the seemingly abrupt terminations of some of our coal-fields are certainly the most difficult problems in geology. Here, the practical man, with a vast field of experience by the side of him, is at a loss how to proceed. What, therefore, has he to do but to seek out the analogous, to learn, if he can, by the known the way to the unknown.

Now, there are certain partial interruptions to the regular courses of the coal-beds in the great northern run of the coal-measures which extends through Derbyshire and Yorkshire, which may help to elucidate the mysteries at the two extremities of that long coal district, and to satisfy us whether they really are terminations, or only great and unusual deflections in the ranges of those strata, deeply hidden and unexplored, and which, better known, (perhaps only by experiment,) may enable us to judge of the probability of uniting or extending our coal-fields.

For solving these important questions on our coal-fields, some few years since noticed by Mr. Coneybeare in a very general way, much may be deduced, both from the observations of geological phenomena, and from experience.

Some are certainly not extricable in the direction of their ranges, while others appear to be so; and, therefore, there is a probability of some of them being united.

Some of the coal-fields, particularly in the middle of the island, seem not yet wrought to any well-defined limits of the coal series; and, consequently, in such cases there is good ground for expecting an extension; and especially as geology, by its settled order of superposition in the rocks, does away old erroneous notions of cut-offs, &c., by the red rock, and by the interposition of faults or dikes.

From the numerous instances of now well-ascertained undulations across the general ranges of the strata, by which their planes are formed into caverns, and, intermediately, in the reverse of these forms, so that the strata of coal may rise on one side up to an unconformable covering, cut off by the red marl or red rock, there may be good reason to expect the coal-measures to go down again on the other side of the so-called anticlinal line at no great distance; and especially where it can be ascertained that such lateral rise of the strata has not brought up the deepest part of the coal series; but, where the millstone girt or mountain limestone, appears, there, with certain exceptions, the case may be decisive.

That there are such opposite lateral rises and dips in the strata, where the coal-measures are deeply unconformably covered by the red marl, is well known in the extensively-wrought collieries of Somersetshire, and, consequently, the planes of the coal are subject to hollows and ridges, though the extent of these irregularities may not yet be known.

We see that the strata, in part, or in whole series of strata in their superficial exposures, form such natural hollows and ridges to a great extent, chiefly across the bearings of their ranges; and, therefore,

we have a right to expect such forms in them, even where they are deeply covered.

The broad and very long coal-field of South Wales terminates north and south, with opposite rises in the strata.

The coal in Durham rises, in its southward boundary, nearer to the surface; so that good coal is found at no great depth beneath its unconformable cover of magnesian limestone.

The northernmost coal of Yorkshire rises northward beneath a cover of the same limestone, and ranges E. and W.; forming, with its south-western boundary, a westerly pointed figure widening and deepening south-eastward.

The question of an east or north-easterly continuation of the coal-measures can only be entertained at the easterly end of the east and west range, before mentioned; but we must previously turn to other places, to see, by analogy, how far any subterraneous deflection in the range of the coal-measures may be thereabout expected.

Along the westerly edge of the coal-measures, both in Yorkshire and Derbyshire, there are well-known irregularities occasioned by elevations and depressions across the general range of the series, causing sinuosities in the marginal edges of the coal-fields. The lands eastward, over the ridges, contract, and those westward, in the hollows, expand the width of the coal-measures; so that the first rise in the north-side of the Dun causes a vacant space between Sheffield and Chapel-town; and the second rise, south of Sheffield, and in Derbyshire, causes a vacant space in the productive coal-measures between the high part of Sheffield Park and Coal Aston; and in the hollow between these two ridges, the coal is thrown back under Sheffield. But there is a greater westward receding in the Dronfield trough, one side of which, rising to the north, causes a long east and west range through Coal Aston.

We have, therefore, north and south of the Dun, two east and west ranging lines of the coal-measures, (similar to, but much shorter than that on the north-side of the Yorkshire coal-field,) from which two east and west ranging lines the coal is known, in both cases, to return and resume its regular course.

That in Derbyshire, from Eckington to Stubly, is several miles in extent: but it is not from the magnitude, but from the similarity, of these irregularities, that we may infer the probability of the coal-measures, in class of the most northerly works in Yorkshire, continuing easterly, or resuming a north or north-easterly range, though it may be at a great distance beneath their unconformably covering strata.

THEORY OF THE SPINNING TOP.

The theory of the motion of the top has occupied, and has puzzled many able men. It is extremely difficult to say, why a top stands at all. I have heard the late Sir John Leslie say that the subject was one of the most difficult in Natural Philosophy. He had a very excellent one, running upon agate, for the same purpose as Troughton's. It spun a long time, but I am not certain as to the exact time. Dr. Arnott in his admirable, but not always correct work, on Physics, thinks he has discovered the true cause, and considers it so important as to point it out in the preface among his "specimens of new disquisition or suggestion." He very correctly points out, (p. 64, of the third edition), the futility of the cause usually assigned "even in philosophical treatises of authority." "Some persons believe," he says, "that a spinning top in a weighing scale would be found lighter than when at rest; and many most erroneously hold that the centrifugal force of the whirling, which of course acts directly away from the axis, and quite equally in all directions, yet, when the top inclines becomes greater upwards than downwards, so as to counteract the gravity of the top." This, though the current opinion, is no doubt erroneous enough; but, in attempting to give the true reason, the author falls into an error equally fallacious. "While the top," to use his own words, "is perfectly upright, its point, being directly under its centre supports it steadily, and, although turning so rapidly, has no tendency to move from the place; but if the top incline at all, the *side* of the peg, instead of the very point, comes in contact with the floor, and the peg then becomes a little wheel or roller, advancing quickly, and, with its touching edge describing a curve, somewhat as a skaiter does, until it comes directly under the body of the top, as before." This is liable to three objections: first, that a cylinder, inclined to one side, and rolling round upon one end, never would roll towards the centre, but rather from it; second, the cause would cease, and the top would immediately fall whenever any small hollow confined its point to one spot, as is frequently the case; and third, if the standing of the top depended on the width of the point, it would follow, that the finer the point the more difficult it would be to keep up the top, and if the peg could be ground to a mathematical point, the top would invariably and instantly fall; but the least observation shows that the tendency to fall is, in mathematical language, no function of the fineness of the point; whoever saw a top spin worse for having a fine point, if the floor were sufficiently smooth and hard?

Before any attempt to give a theory of its motions, it would be well to observe carefully what those motions are—how far essential, and how far accidental—and also to institute experiments to discover in what manner the different motions are effected by a change of circumstances. We shall find, then, that a top has four distinct motions; first, a *rotary motion* on its axis, corresponding to the diurnal motion of the earth, and of course essential; second, an *erratic motion*, corresponding partially to the earth's annual motion,—this motion depends on the thickness of the point, and is, of course, not essential, since it may be confined; third, a *conical motion of its axis*, in which the top of the axis slowly describes a circle altogether differing from the rotary motion, and keeping no time with it; it corresponds exactly to the well-known conical motion of the earth's axis, completed in the long period of 25,000 years, and occasioning the precession of the equinoxes; this motion is slowest when the rotary motion is most rapid, and quickens as the latter diminishes; it is slowest, also, in those tops which have the shortest pegs, and ceases altogether when the centre of gravity is brought so low as the point of the peg; this motion is, of course, essential, so long as the centres of gravity and of motion do not coincide; there is also a fourth motion, which will almost invariably be found to some extent, though altogether contingent and depending, I suspect, upon the imperfection of the mechanism, viz.,

upon the load, and being equally poised on every side of the centre of motion; it is a minute circular movement of the axis describing a coil of very small circles around the circumference of the circle described by the third motion; it very prettily illustrates the motion called in astronomy the *nutation* of the earth's axis, except that it differs from it essentially in its rapidity, being concomitant with the first motion.

From what I have said it will appear that there is some harmony between the motions of a top and those of the planetary bodies. Sneer at tops who will, the earth itself, as to its motions, is nothing else than a large spinning top; and any one attempting to give or to obtain a clear idea of the various planetary movements will find the top a most useful auxiliary. It is remarked by Sir J. Herschel, in his volume on Astronomy in Lardner's Cyclopædia,—(Art. 266), "that a child's peg-top or te-totum, when delicately executed and nicely balanced, becomes an elegant philosophical instrument, and exhibits, in the most beautiful manner, the whole phenomenon, (of the precession of the equinoxes), in a way calculated to give us at once a clear conception of it as a fact, and a considerable insight into its physical cause as a dynamical effect." But, unfortunately for this purpose, the motion is always in the wrong direction, being *along with*, instead of *contrary to*, the direction of the rotary motion. The question arises, how is this to be accounted for, or can it be obviated? It appeared to me, that, since this motion is retarded by shortening the peg and lowering the centre of gravity, it would cease altogether if the centres of motion and of gravity were made coincident, and, upon further extending the same change, which gradually annihilated the positive motion, that motion would re-appear negative. I had, therefore, a top constructed, with an axis capable of being raised or lowered at pleasure, by means of a screw; it was made to spin in a very small glass cup, fixed on a narrow stem, and, a conical hole, cut in the bottom of the top, permitted the cup to be raised within the top above its centre of gravity. This I found exactly to answer my expectation, it permitted the motion to be quickened, retarded, annihilated or reversed at discretion, and, in fact, tamed its usual wild vagaries, and brought them into perfect control. As it was confined to one spot, I could fix a wooden circle round it for the ecliptic, a thin rim of lead marking its equator. I could then make it spin with any degree of inclination of the two circles that I chose, and, by lowering the centre of gravity a little below the centre of motion, I could then show the conical motion of the axis and the two equinoctial points slowly moving in a *contrary* direction to the top, and taking as much as five or ten minutes to describe a single revolution. If the point is fine, the inclination of the equator to the ecliptic will be preserved without any apparent diminution, but, if not, the inclination will gradually decrease until the top attain a vertical position.

By this means, with a few additional contrivances, we may illustrate almost every astronomical movement. The top, with its stand, may be carried where we please, or swung suspended by a long string, to show the earth's annual revolution, while the other motions are going on at the same time. The string will, of itself, almost invariably take an elliptic rather than a circular orbit, and, if suspended from the hand, a delicate motion of the finger will show the advance of the earth's apsides. If, again, we substitute for the body of the top, two balls attached to each other, or to a heavy ring, we may show the relative motions of the earth and moon, the retrogradation of the nodes and all the phenomena of eclipses. The volutions of the top, however, not only *illustrate* those of the planets, but appear to me to *depend upon the same causes;* and I am persuaded that the same theory on which they depend may be made even to explain, if not practically to illustrate, the hitherto unsolved problem of the eccentric revolutions of Saturn's rings, and the stability of their equilibrium.—*Cor. Liv. Mercury.*

To the Editor.

SIR.—On Friday evening last, I put three or four bottles of water on the shelf, for experiments the next day. The morning following I was surprised to find they were not frozen, and on taking out the stopper of one of them to pour the water into another vessel, I had barely decanted a tea spoonfull, when the whole was suddenly converted into a mass of ice. I then took another bottle, and taking out the stopper, shook it, when it immediately shot out into the most beautiful ramifications, resembling fern leaves, and in a few seconds the whole was congealed. I then took a third bottle, and shook it, without touching the stopper, when there was no congelation, nor did it take place with the fourth bottle, when I took out the stopper without agitating it. It is evident from the above, that the congelation took place by the united effects of agitation and the atmospheric air, but in what manner those forces operate conjointly, or why they should both be necessary, is what I cannot find anywhere explained.

You will at once perceive the resemblance between this and the well-known experiment with Glauber's salts, but it will be difficult to reconcile both to the same theory. We must be certain the water was considerably below 32° and that consequently caloric must have been evolved at the moment of congelation—its bulk also must have been expanded. Now with regard to the atmospheric air, the query is, when the stopper was taken out, has the air in the bottle escaped, or has the atmosphere ingress? It is equally difficult to conceive in what manner agitation influences the crystallization, without we suppose the primary particles of the water to be in a *nascent* state of solidity, and that these particles must each have an individual *polarity*, in such a position, that they mutually repel each other, (which may account for the expansion of water when cooled below 32°) and agitation, by reversing the polarity, and bringing the attractive forces into operation, causes the crystals to unite to each other, and forms ice. But as this is but a vague theory of my own, I should deem it a great favor could you or your correspondents unfold the principles of its action. J. C.

Varieties of Gold.—Goldsmiths usually indicate the purity of the gold they sell in the following manner. Perfectly pure gold, they suppose divided into 24 parts called carats. Gold of 24 carats therefore means pure gold; gold of 23 carats, means an alloy of 23 parts gold, and one of some other metal, and so on. The number of carats, mentioned, indicates the pure gold, and what that number wants of 24, indicates the quantity of alloy.

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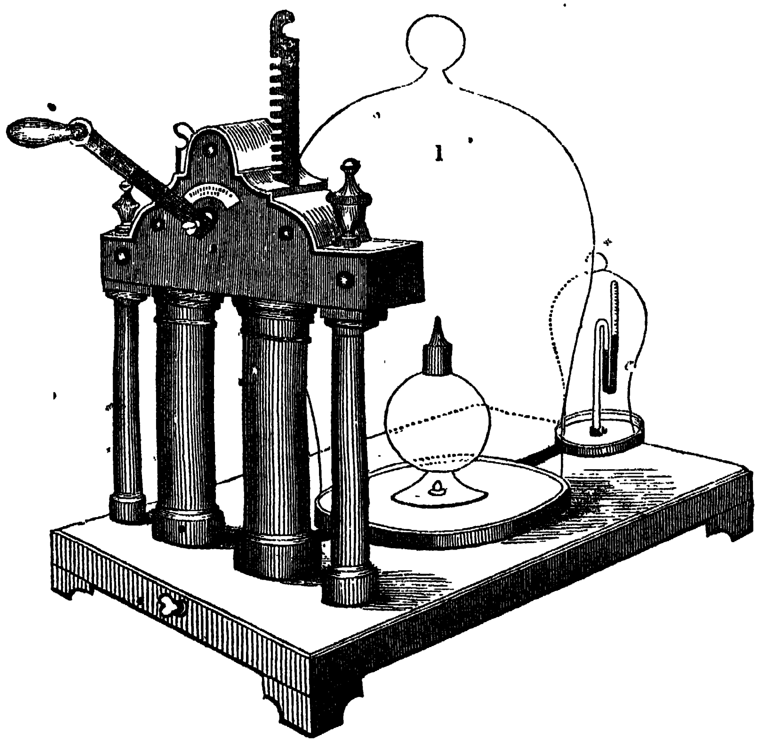
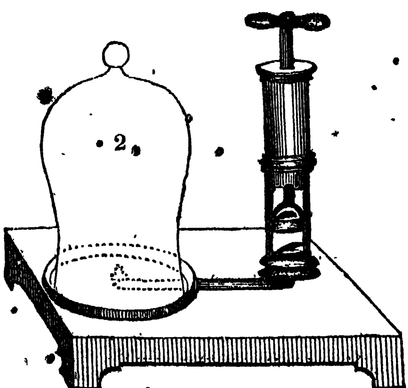
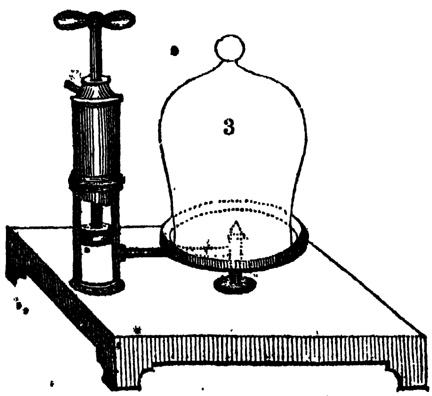


AIR PUMPS.





THE AIR PUMP.

In philosophical investigations it frequently becomes necessary that the substances which are the subjects of experiment should be removed from the influence, whether mechanical or chemical, of the atmosphere.

For this purpose it is desirable, that we should possess the means of withdrawing the air from a glass vessel called a receiver, in which the substance is placed, and through which the changes which it suffers may be observed. The space under the glass vessel after the air has been withdrawn from it is called a vacuum, and the machine by which the air is withdrawn is called an air pump. We shall devote the present paper to explain the construction of this instrument, and the principles which govern its action.

The air pump is exhibited under various forms, each of which is attended with particular advantages and disadvantages, according to the purposes to which it is applied. There are, however, some general principles in which all modifications of this interesting machine agree, and which we shall first explain.

Let Fig. 2 be the section of a glass vessel closed at the top, but open at the bottom, and having its lower edge ground smooth, so as to rest in close contact with a smooth brass plate. When the receiver is thus placed upon the plate, it will with the assistance of a little unctuous matter previously rubbed on the edge of the glass, be in air-tight contact. In the plate is a small aperture which communicates by a tube, with a cylinder in which a solid piston is moved. The piston-rod moves in a collar, and a valve is placed in the bottom of the cylinder opening outwards.

Let the air in the receiver, the pipe connected with it, and the barrel be first supposed to have the same density as the external air; upon elevating the piston, the air in the barrel will be drawn out, and a vacuum will be formed underneath the piston. The air then in the receiver will, by its elasticity, force against the valve at the bottom of the barrel, and rush up to fill the vacant space. When the piston is forced down again, it compresses the air beneath it, which closes the valve at bottom, and at the same time, opens the valve which is in the piston itself, and the compressed air thereby escapes; thus a quantity of air equal to the capacity of the barrel is got rid of—a second lift will withdraw a second portion, and so the operation may be continued at pleasure.

At the commencement of the process the air which fills the receiver, exhausting tube, and barrel, is of the density of the external air; let its entire quantity in this state be called one. Let the capacity of the barrel bear any proposed proportion to that of the receiver and tube; suppose that it is one-third of their united magnitudes, and therefore that it contains one-fourth of the air contained within the entire apparatus. Upon the first depression of the piston this fourth part will be expelled, and three-fourths of the original quantity will remain. One-fourth of this will in like manner be expelled upon the second depression of the piston which is equivalent to three-sixteenths of the original quantity, and consequently there remains in the apparatus nine-sixteenths of the original quantity.

The method by which the computation might be continued is obvious. The air expelled at each stroke is found, by multiplying the air expelled at the preceding stroke by 3 and dividing it by 4; and the air remaining after each stroke is also found by multiplying the air remaining after the preceding stroke by 3, and dividing it by 4.

It appears by this computation, that after the fifth stroke, the remaining air in the receiver is less than one-fourth of the original quantity. Less than one-fourth of this will remain after the next five strokes, that is, less than one-sixteenth part of the original quantity. If we calculate that every five strokes extract three-fourths of the air contained in the apparatus, we shall then underrate the rapidity of the exhaustion; and yet, even at this rate, after thirty strokes of the pump, the air remaining in the receiver would be only one 3096th part of the original quantity. The pressure of this would amount to about the sixteenth part of an ounce upon the square inch. It is evident that by continuing the process any degree of rarefaction which may be desired can be obtained. For all practical purposes, therefore, a vacuum may be considered to be procured; but, in fact, we are as far from having a real vacuum in the receiver as ever, for such is the infinite expanding power of air that the smallest particle will as completely fill the receiver and barrel as the most dense substance could; that is to say, no part of the receiver or barrel, however small, will be found absolutely free from air, however long the process of exhaustion may be continued.

After the explanation of the single barrel air pump, above given, that of the double barrelled pump will be easily understood: we have only to consider that the tube which proceeds from the brass plate in the centre, is branched so as to communicate with two barrels instead of one, that each barrel is furnished with its valve and piston, and that these pistons are moved alternately up and down by a wheel moved backwards and forwards by the similar motion of a handle.

Fig. 3, shows an air pump entirely without valves, and which is so simple, that it may be made by any person without difficulty. It was the invention of the late professor Ritchie. The stand, receiver, brass plate, &c., are the same as before, in the barrel is the only difference. It is seen from the figure that this barrel proceeds below the tube which communicates with the receiver. The piston is quite solid, and works through an air-tight collar at top; also near the top of the barrel is a small hole, which may be closed by the finger. Upon driving down the piston to its full extent, the air will occupy the whole of the barrel above, equally with the receiver. Upon drawing up the piston, as soon as it gets above the connecting tube, it will draw out the air in the upper part of the barrel, as will be felt, by its issuing from the small hole at top. When the piston is at the upper end of the barrel, the hole must be stopped with the finger laid upon it. While the portion of air above the piston was escaping, the air in the receiver was filling the vacancy made in the barrel beneath; but as soon as the piston is forced down again, it is forced back into its place, until the piston reaches the bottom. As during this descent, the finger prevented the entrance of the atmospheric air from without, a vacuum was formed, and the air in the receiver rushes out to fill the void—a second stroke of the piston therefore will remove another portion of air, the finger being removed to allow it egress; thus by drawing the piston up and down, being very careful to cover the hole with the finger at all times, except in the upward stroke, the air will soon be exhausted from the receiver.

SILVERING LOOKING GLASS.

A PIECE of glass being transparent, is not calculated to act as a looking-glass, because the reflection of the face or of any other object from it is too faint to answer the desired purpose. If we blacken the back of a piece of glass, or hold a dark object immediately behind it, the reflection becomes more distinct, but is still altogether insufficient for the purposes to which a looking-glass is applied. It is necessary, therefore, to cover one side of the glass with some metallic substance which will yield a good reflection through the glass.

Many persons suppose that the metal employed for this purpose is silver; indeed, they are justified in so supposing, from the name which the silverer gives to his employment. The metal employed is, however, mercury, or quicksilver; this latter name, which means "living silver," was given to this metal by the ancients, probably on account of the lively and vivid appearance which it presents; and as "silver" is a shorter word to pronounce than "quicksilver," it is probable that this is the reason why the process of which we are speaking is always called "silvering.

Mercury being a liquid, it is necessary to employ some other substance to cause it to adhere to the glass; for it would not be sufficient to lay it on with a brush, as we should whitewash on the ceiling, or paint on the wall, of a room, and there let it dry; mercury rolls off glass as drops of water do off a greasy board. The substance employed to make the mercury adhere to the surface of the glass is tin-foil, which is as thin as paper, and which has, to use a chemical term, a strong attraction for mercury; the effect of which is, that a drop of mercury combines with, or is absorbed by the tin-foil, and they both become one substance, which adheres pretty firmly to glass.

The various processes which the silverer performs to attain this object we now proceed to detail.

The glass which is to be silvered is made perfectly clean on both sides, particularly on that which is to be silvered; for if the slightest mist or speck of dirt be allowed to remain on the surface, it will appear very conspicuous when the glass is silvered. The tin-foil, which is the next object of attention, is generally made in sheets about six feet long and of various widths, varying from ten inches up to forty, the diversity of widths being to enable the silverer to cut out small pieces suitable to various sized glasses. For larger sizes, the foil is generally made to order, and of a greater thickness than for smaller glasses.

A sheet of tin-foil being unrolled, is laid down flat, and cut to the same shape as the glass, but an inch larger each way. It is then laid down as smoothly as possible on the silvering-stone, which is a very large and carefully-prepared slab of slate, porphyry, or marble, perfectly flat and smooth. The foil is worked out level and smooth on the silvering-stone by means of a smooth wooden roller, which is worked over it in every direction.

The mercury employed, whether for this or any other manufacturing process, is brought to this country either from Almaden, in Spain, or from Istria, in the Austrian empire, at both of which places quicksilver mines are situated. The metal is contained in a mineral called cinnabar, with which Almaden, in particular, abounds. There are at Almaden twelve large ovens, each capable of containing about ten tons of cinnabar; and by heating and subsequent processes, from three to ten ounces of mercury are obtained from every pound of the ore or cinnabar dug from the mine. The mercury is put into tall narrow iron bottles, each capable of containing about 100lbs. weight, and in that form it is shipped off to foreign countries.

The silverer, when all is ready for silvering a glass, pours some mercury from one of the iron bottles into a wooden bowl, and then, by means of an iron ladle, pours the mercury over the whole surface of the foil till every part is covered. The glass plate is then laid upon the liquid mercury; but this operation is done in a very remarkable manner. The glass is not laid at once flat down on the mercury, but is made to slide on, the edge of the glass first coming in contact with the mercury. As it is slid along, it pushes before it the greater part of the mercury, because the edge of the glass almost scrapes along the foil as it passes. The reason of this mode of placing the glass on the foil is, that all air-bubbles and impurities may be pushed off, allowing only a thin film of very pure mercury to remain between the glass and the foil.

In all of this there is much care and delicacy required. In the first place, it is a matter of some difficulty to clean the glass so perfectly as not to show any marks or streaks after it is silvered; indeed, it is often necessary to remove it from the foil two or three times after it has been laid down, in order to wipe off specks of dirt which are visible when the glass is silvered, however difficult of detection they may previously be: this is especially the case in damp weather. This renders it necessary that the foils for large glass (which necessarily require a longer time than small ones to perform the different processes) should be thicker than those for smaller; for such is the attraction between the mercury and the foil, that if a glass, after having been removed for farther cleaning, be not speedily replaced on the mercury, the latter will combine with the foil, and give it a rottenness which will prevent its adhesion to the glass: the thicker the foil, therefore, the less is this likely to occur.

Another point of great importance is, that the plate should be so dexterously slid over the surface of the foil as to remove all air-bubbles in its progress, and is one of those instances in which a description of the process, although it may explain how it is done, will go but a little way in qualifying the reader to perform it.

When the glass is properly placed on the tin-foil, and it is ascertained that all specks and air-bubbles are removed, it is covered almost in every part by heavy iron or leaden weights; so that a large glass will have several hundred weight pressing upon it. It may, and often does, excite surprise that such a pressure does not break the glass; but that it does not do so is a sufficient proof how perfectly flat both the glass and the silvering-stone must be. This pressure is intended to force out from between the glass and the foil as much mercury as possible, so that the thinnest film only of mercury shall remain between them. To effect this more completely, the silvering-stone is made to rest on a swivel or axle underneath, by which it can be made either perfectly horizontal, or thrown into an inclined position. While the glass is being laid on the foil, the silvering-stone is horizontal, to prevent the mercury from flowing off; but when the superfluous mercury is to be drained off, the stone is made to assume an inclined position, so as to ensure one general direction for the flow of the mercury.

A trough or hollow groove runs round the sides of the stone, into which the mercury flows as it is forced out from between the glass and the foil. A pipe, descending from one corner of this trough, conveys the mercury into a bottle placed beneath to receive it. Although an immense weight of mercury (which is about thirteen or fourteen times as heavy as water) must be poured on the foil for the silvering of a large glass, yet the quantity which actually remains between the glass and the foil is extremely small.

The glass, with the weights upon it, is allowed to remain in the inclined position for several hours, or, if the glass be large, it is allowed to remain until the next day, in order that as much as possible of the mercury may be pressed out before the weights are removed. On the removal of the weights, one end of the glass is tilted up and supported by blocks, the other end still remaining on the stone. A piece of foil is then laid on the lowest corner, to draw off the mercury (somewhat in the manner of a sponge) which collects in a little pool at the bottom of the glass. In this state the glass remains from a few hours to three or four days according to its size.

When as much of the mercury as possible has drained from the glass in this way, the glass is taken up;—when it is found, that the mercury and the foil adhere to each other and also to the glass:—the fact is, that the two metals have combined together, and in the combined state adhere to the glass, which neither the one nor the other would have done separately. Any combination of mercury with another metal, however produced, is called in chemical language, an amalgam; in the present case, we have an amalgam of tin, due to the combination of the mercury with the tin-foil.

The removal of the glass from the stone is effected in different ways, according to its size. If it is not too wide for the arm-span of the silverer, he takes it by the two edges and lifts it up from the stone, from whence he places it edgeways on a shelf or on the floor of the silvering room, resting its upper edge against the wall, and allowing one corner to be lower than the rest, so as to facilitate the draining towards that corner. If the glass be long and narrow, two men can take it up instead of one, but in the same manner. If however the glass be very large, the following mode is sometimes adopted. The draining room is situated beneath the silvering room, and an opening in the floor of the latter is so situated, that a portion of the silvering table can be let down through it, on account of its facility of motion round the swivel. By a gradual turning of the silvering table, therefore, the stone, and the glass which is upon it, can be brought into a nearly perpendicular position. In this position of the glass (which sometimes weighs as much as 200lbs.), several men in the lower room grasp it by the edges, and place it against the wall of the room, where it is left to drain.

When the plate is thus placed against the wall of the room, it is left to drain for a time varying from one day to several days, according to its size; in order that any remaining superfluous mercury may leave it, and that the foil may become still better attached to the surface of the glass. When the draining appears to be complete, the glass is ready to be applied to its intended purpose.

The above is the process for silvering plate glass. But there is an important reason why common glass, used for cheaper purposes (such as the inferior sort of dressing-glasses), cannot be silvered in this way; for any heavy pressure on such glass breaks it at once, on account of its thinness and crookedness. These common glasses (which are always small in size) are not silvered on a stone, but on a board or flat box. The foil, which is thinner for these purposes, is cut to the requisite size, and laid on the board and covered with mercury, as in the former instance. But instead of sliding the glass on the mercury, a piece of clean paper is laid on the mercury, and the glass is laid on the paper. The silverer now, laying one hand pretty firmly on the glass, lays hold of the edge of the paper with the other, and by a smart dexterous action, draws out the paper from between the glass and the foil, and with it the greater part of the mercury, together with air-bubbles, impurities, &c.,—leaving the glass resting on a thin but brilliant film of mercury: this is a process requiring much manual dexterity, and yet an Italian (for most of the silverers of common glasses are Italians) can often silver a hundred dozen small glasses in one day.

The common glass employed for these purposes is always crooked and irregularly bent at its surfaces: and it is a general rule to silver the concave side, when one side is, generally speaking, more concave than the other. The crown glass now made is better than that which was produced a few years ago, and although it is always curved, yet the curvature is pretty nearly the same in different tables from the same crate. This circumstance assists the silverer, for each silvered glass acts as a weight to another of the same size. It is usual to silver a great number of the same size at the same time; and as each one is silvered, it is placed flat down on a shelf, or in a shallow box; and on it the others are successively laid as they are silvered. The concave side of each is silvered, and as the concavity is nearly equal in all, each one helps to press out the superfluous mercury from the one beneath it. This therefore is, in some degree, equivalent to the leaden weights employed with plate glass. The silvering in common glasses is, however, seldom found to be so perfect as on plate glass, from the impossibility of giving equal pressure in every part.

SUBSTITUTES FOR YEAST IN MAKING BREAD.

First Receipt.—Mix with twelve lbs. of flour one oz. of carbonate of soda, along with the usual quantity of salt. Knead the whole up with *sour* butter-milk; if very sour, half water and half butter-milk will do; but all butter-milk is preferable, which will be no worse if kept one, two, or three weeks before used; *the more acid the better*. The dough will be ready for baking in a quarter of an hour, as the fermentation goes on while kneading; but it will take no harm by standing one, two, or three hours.

The butter-milk must be acid, the soda pounded small, and well mixed with the flour, and the oven brisk, or the bread will probably be heavy, and taste of the soda.

Second Receipt.—Put one oz. of hops into a coarse bag, and boil them in two quarts of water; pare, boil, and mash one lb. of potatoes very well, and press them through a cullender into the hop water. Place the mixture on the fire until it begins to boil, then empty it into an earthen vessel with a narrow bottom, in which there has been previously mixed half a pound of flour, with a gill of cold

water, in the form of a paste; stir it well while pouring in, and when it is about the warmth of new milk, put in four oz. of dry flour, and a pound of common yeast, let it stand in the vessel, covered up, in a situation where it will keep its temperature. It takes from four to twenty-four hours to ferment, according to the state of the weather. When it begins to lower in the vessel, it is fit for immediate use; or may be preserved, when put in a bottle and corked up, for several weeks. Should it be frozen, it will be no worse after being thawed.

In case you have no Barm wherewith to begin.—Make about a pint or quart in the manner above directed, except in one particular; instead of putting any barm with the dry flour into the mixture, put two or three spoonsful of sugar with the flour; bottle it immediately, and having tied down the cork, set it where it will keep warm, and in twenty-four or thirty hours this will answer to ferment with, instead of the common barm. But it is always better to preserve some of the old for this purpose.

Directions for Use.—Take twelve or fourteen lbs. of flour; when you have mixed the salt with it in your kneading vessel, as is usual, make a hole in the middle, and pour in one lb. of the barm; let the water for kneading be two parts of boiling water to one of cold, in winter; and in summer an equal quantity of each; the water should be soft. When the dough is of proper consistence, cover it up, and *keep it warm while it rises*, which will probably be from five to ten hours. If kneaded at night, it will be fit for baking in the morning; but if it should not then be ready, (which may be the case if kept too cool in the night,) by applying a hot iron plate under the vessel containing the dough, it will in a short time be fit for baking.

The first receipt is excellent; and as butter-milk contains much real nutriment, it is to be preferred in country places to the common yeast, more particularly during summer, when it can be conveniently procured, in an acid state, and at a cheap rate. It gives the bread a rich flavor, unequalled by any other substitute. Several ladies of Barnsley have used it for more than two years, with great satisfaction, except during the winter, when, from the butter-milk not being sufficiently acid, the bread was not so light as when the barm made from the second receipt was used.

ON ECHOES.

ECHOES are well known; but however common this phenomenon may be, it must be allowed that the manner in which it is produced is still involved in considerable obscurity, and that the explanation given of it does not sufficiently account for all the circumstances attending it.

Almost all philosophers have ascribed the formation of echoes to a reflection of sound, similar to that experienced by light, when it falls on a polished body. But, as D'Alembert observes, this explanation is false; for if it were not, a polished surface would be necessary to the production of an echo; and it is well known that this is not the case. Echoes indeed are frequently heard opposite to old walls, which are far from being polished; near huge masses of rock, and in the neighbourhood of forests, and even of clouds. This reflection of sound therefore is not of the same nature as that of light.

It is evident however, that the formation of an echo can be ascribed only to the repercussion of sound; for echoes are never heard but when sound is intercepted, and made to rebound by one or more obstacles. The most probable manner in which this takes place, is as follows.

For the sake of illustration, we shall resume our comparison of the aërial moleculæ to a series of elastic globules. If a series of elastic globules then be infinite, it may readily be conceived, that the vibrations communicated to one end, will be always propagated in the same direction, and continually recede; but if the end of the series rest against any fixed point, the last globule will re-act on the whole series, and communicate to it, in the contrary direction, the same motion as it would have communicated to the rest of the series, if it had not rested against a fixed point. This ought indeed to be the case whether the obstacle be in a line with the series, or oblique to it, provided the last globule be kept back by the neighbouring ones; only with this difference, that the retrograde motion will be stronger in the latter case, according as the obliquity is less. If the aërial and sonorous moleculæ then rest against any point at one end; and if the obstacle be at such a distance from the origin of the motion, that the direct and re-percussive motion shall not make themselves sensible at the same instant, the ear will distinguish the one from the other, and there will be an echo.

But we are taught by experience, that the ear does not distinguish the succession of two sounds, unless there be between them the interval of at least one-twelfth of a second; for during the most rapid movement of instrumental music, each measure of which cannot be estimated at less than a second, twelve notes are the utmost that can be comprehended in a measure, to render the succession of sounds distinguishable; consequently the obstacle which reflects the sound must be at such a distance, that the reverberated sound shall not succeed the direct sound till after one-twelfth of a second; and as sound moves at the rate of about 1142 feet in a second, and consequently about 95 feet in the twelfth of a second, it thence follows that, to render the reverberated sound distinguishable from the direct sound, the obstacle must be at the distance at least of about 48 feet.

There are single and compound echoes. In the former only one repetition of the sound is heard; in the latter there are 2, 3, 4, 5, &c. repetitions. We are even told of echoes that can repeat the same word 40 or 50 times.

Single echoes are those where there is only one obstacle; for the sound being impelled backwards, will continue its course in the same direction without returning; but double, triple, or quadruple echoes may be produced different ways. If we suppose, for example, several walls one behind the other, the remotest being the highest; and if each be so disposed as to produce an echo, as many repetitions of the same sound as there are obstacles will be heard.

There are some echoes that repeat several words in succession; but this is not astonishing, and must always be the case when a person is at such a distance from the echo, that there is sufficient time to pronounce several words before the repetition of the first has reached the ear.

There are some echoes which have been much celebrated on account of their singularity, or of the number of times that they repeat the same

word. Misson, in his Description of Italy, speaks of an echo at the Villa Simonetta, which repeated the same word 40 times.

At Woodstock in Oxfordshire, there is an echo which repeats the same sound 50 times. This seems to be a mistake; the echo at Woodstock, according to Dr. Plat, repeats in the day time very distinctly 17 syllables, and in the night time 20.

The description of an echo still more singular near Roseneath, some miles distant from Glasgow, may be found in the Philosophical Transactions for the year 1698. If a person, placed at the proper distance, plays 8 or 10 notes of an air with a trumpet, the echo faithfully repeats them, but a third lower; after a short silence another repetition is heard in a tone still lower; and another short silence is followed by a third repetition, in a tone a third lower.

A similar phenomenon is perceived in certain halls; where, if a person stands in a certain position, and pronounces a few words with a low voice, they are heard only by another person standing in a determinate place. Muschenbroeck speaks of a hall of this kind in the castle of Cleves; and most of those who have visited the Observatory at Paris have experienced a similar phenomenon in the hall on the first story.

Philosophers unanimously agree in ascribing this phenomenon to the reflection of the sonorous rays; which, after diverging from the mouth of the speaker, are reflected in such a manner as to unite in another point. But it may be readily conceived, say they, that as the sound by this union is concentrated in that point, a person whose ear is placed very near will hear it, though it cannot be heard by those who are at a distance.

We do not know whether the hall at the castle of Cleves, of which Muschenbroeck speaks, is eliptical, and whether the two points where the speaker and the person who listens ought to be placed are the two foci; but in regard to the hall in the Observatory at Paris, this explanation is entirely void of foundation. For,

1st. The echoing hall, or as it is called the *Hall of Secrets*, is not at all elliptical; it is an octagon, the walls of which at a certain height are arched with what are called in architecture *cloister arches*, that is to say, by portions of a cylinder which, in meeting form re-entering angles, that continue those formed by the sides of the octagonal plan.

2nd. The person who speaks does not stand at a moderate distance from the wall, as ought to be the case in order to make the voice proceed from one of the foci of the supposed ellipsis; he applies his mouth to one of the re-entering angles, very near the wall, and the person whose ear is nearly at the same distance from the wall, on the side diametrically opposite, hears the one who speaks on the other side, even when he does so with a very low voice.

It is therefore evident that, in this case, there is no reflection of the voice according to the laws of catoptrics; but the re-entering angle continued along the arch, from one side of the hall to the other, forms a sort of canal, which contains the voice, and transmits it to the other side. The phenomenon is entirely similar to that of a very long tube, to the end of which if a person applies his mouth and speaks, even with a low voice, he will be heard by a person at the other end.

The Memoirs of the Academy of Sciences, for the year 1692, speak of a very remarkable echo in the court of a gentleman's seat called Le Genetay, in the neighburhood of Rouen. It is attended with this singular phenomenon, that a person who sings or speaks in a low tone, does not hear the repetition of the echo, but only his own voice; while those who listen hear only the repetition of the echo, but with surprising variations; for the echo seems sometimes to approach and sometimes to recede, and at length ceases when the person who speaks removes to some distance in a certain direction. Sometimes only one voice is heard, sometimes several, and sometimes one is heard on the right, and another on the left. An explanation of all these phenomena, deduced from the semicircular form of the court, may be seen in the above collection.

CHEMICAL ACTION OF LIGHT.

At the meeting of the French Academy of Sciences on the 11th of January, M. Biot made a report of the researches of M. Edmund Becquerell, on the chemical action of the rays of solar light.

Certain substances, as is well known, have the property of being modified in their characters and in their internal composition by the action of light. It is on this fact the chief operation of the Daguerreotype depends. For instance, the slight coating of iodine with which the silvered plate is covered by exposing it to the vapour of iodine, is modified by the light from the objects concentrated in the camera obscura; and the force of this action is proportioned to the intensity of the luminous rays. Is it the light itself—merely as light—which produces this effect? which thus blackens, for example, paper impregnated with chloride of silver? It has been shown that it is not, by causing the light to pass through a substance perfectly transparent, which does not obstruct its passage in the least nor diminish its brightness, and which, nevertheless, becomes thus deprived of its chemical properties. These properties are thus removed by the light traversing through certain diaphanous substances, which allow the light itself to pass, stopping only in its progress the chemical rays. On the other hand, the brightness of the light may be diminished without in any way affecting its chemical properties; which effect takes place when the rays pass through blue glass. Thus it appears, that the rays which are emitted from the sun consists of two kinds, of very contrary qualities, acting generally together, but which may be separated by some of the means already indicated. These are, the luminous rays, properly so called, and the rays which are invisible, but are appreciable by their effects, which have been called chemical rays, for the want of a better term.

The attention of M. Becquerell has been directed especially to the consideration of the latter rays. This young and skilful philosopher has discovered a remarkable circumstance regarding these rays and their effects on substances sensible to their action. A piece of paper impregnated with one of these substances may be exposed in a camera obscura to the different rays of solar light, decomposed by the prism, without undergoing any change; whilst, if the paper be previously exposed to daylight, for as short a time as possible—for the space of a second or half a second—the action of the light so weakly commenced and scarcely perceptible, will be continued in the solar spectrum in such a manner that soon all parts of the paper which had previ-

ously been exposed to day-light will change from white to black, according as they are exposed to the rays of the prism; whilst the same paper, if kept in a dark place after its momentary exposure to the light, will preserve its white color atmost entire. Thus we perceive, in the one case, no action from the rays of the spectrum on the sensitive paper which has not been previously exposed to the light; and in the other, on the contrary, the continuation of that action on the rays of the spectrum, when it has only been just commenced by the solar light. This is one of the principal results from the experiments of M. Becquerell; and in this, perhaps, consists the secret of the new modification announced by M. Arago, in the photogenic process of M. Daguerre, which enables it to produce images by exposing the prepared plate for a second only in the camera obscura.

It may, in fact, be conceived, having seen the memoir of M. Becquerell, that the plate coated with iodine might, after having received the impression of the object for only a second, be exposed to the rays of the solar spectrum in which the action—commenced by the luminous rays from external objects—might be completed, as in the experiment of M. Becquerell; so as to enable the mercurial vapor to produce the effect which it is known to do in the ordinary process of Daguerreotype, and render the image visible.

All these discoveries and modifications originate from the fundamental fact on which the two principal operations of the Daguerreotype depend; from which we learn that a substance may be modified by light, without any change being perceived by the eye, in such a manner that an image may be produced, invisible at first, which becomes visible by the action of another agent. This effect is produced by the vapor of mercury; which attaches itself to those parts of the coating of iodide of silver which are more or less affected by the luminous rays. This important fact, discovered by M. Niepce, will, we have no doubt, be applied in other methods, and be productive of further consequences.

MARBLE.

(Resumed from page 349, and concluded.)

Modern marbles.—1. British. Black marble is found at Ashford, Matlock, and Monsaldale in Derbyshire; black and white in the north part of Devonshire; the variegated marbles of Devonshire are generally reddish, brownish, and greyish, variously veined with white and yellow, or the colors are often intimately blended; the marbles from Torbay and Babbacombe, display a great variety in the mixture of their colors; the Plymouth marble is either ash-colored with black veins, or blackish-grey and white, shaded with black veins; the cliffs near Marychurch exhibit marble quarries not only of great extent, but of superior beauty to any other in Devonshire, being either of a dove-colored ground with reddish-purple and yellow veins, or of a black ground mottled with purplish globules. The green marble of Anglesea is not unlike the *verde antico*; its colors being greenish-black, leek-green, and sometimes dull purplish, irregularly blended with white. The white part is limestone, the green shades proceed from serpentine and asbestos. There are several fine varieties of marble in Derbyshire; the mottled-grey in the neighbourhood of Moneyash, the light grey being rendered extremely beautiful by the number of purple veins which spread upon its polished surface in elegant irregular branches; but its chief ornament is the multitude of *entrochi*, with which this transition limestone-marble abounds. Much of the transition and carboniferous limestone of Wales and Westmoreland is capable of being worked up into agreeable dark marbles.

In Scotland, a particularly fine variety of white marble is found in immense beds, at Assynt in Sutherlandshire. A beautiful ash-grey marble of a very uniform grain, and susceptible of a fine polish, occurs on the north side of the ferry of Ballachulish in Invernesshire. One of the most beautiful varieties is that from the hill of Belephetrich in Tiree, one of the Hebrides. Its colors are pale blood-red, light flesh-red, and reddish-white, with dark green particles of hornblende, or rather sahlite, diffused through the general base. The compact marble of Iona is of a fine grain, a dull white color, somewhat resembling pure compact felspar. It is said by Bournon, to consist of an intimate mixture of tremolite and carbonate of lime, sometimes with yellowish or greenish-yellow spots. The carboniferous limestone of many of the coal basins in the lowlands of Scotland may be worked into a tolerably good marble for chimney-pieces.

In Ireland, the Kilkenny marble is the one best known, having a black ground more or less varied with white marks produced by petrifiactions. The spar which occupies the place of the shells, sometimes, assumes a greenish-yellow color. An exceedingly fine black marble has also been raised at Crayleath in the county of Down. At Louthlougher, in the county of Tipperary, a fine purple marble is found, which when polished looks very beautiful. The county of Kerry affords several variegated marbles, not unlike the Kilkenny.

France possesses a great many marble quarries which have been described by Brard, and of which a copious abstract is given under the article marble, in *Rees' Cyclopedia.*

The territory of Genoa furnishes several beautiful varieties of marble, the most remarkable of which is the *polzevera di Genoa*, called in French the *vert d' Egypte* and *vert de mer*. It is a mixture of granular limestone with a talcose and serpentine substance disposed in veins; and it is sometimes mixed with a reddish body. This marble was formerly much employed in Italy, France, and England, for chimney-pieces, but its sombre appearance has put it out of fashion.

Corsica possesses a good statuary marble of a fine close grain, and pure milky whiteness, quarried at Ornofrio; it will bear comparison with that of Carrara; also a grey marble (*bardiglio*,) a cipolin, and some other varieties. The island of Elba has immense quarries of a white marble with blackish-green veins.

Among the innumerable varieties of Italian marbles, the following deserve especial notice:—

The *rovigio*, a white marble found at Padua; the white marble of St. Julien, at Pisa, of which the cathedral and celebrated slanting tower are built; the Biancone marble, white with a tinge of grey, quarried at Maguregа for altars and tombs. Near Mergozza, the white saline marble with grey veins is found, with which the cathedral of Milan is built. The black marble of Bergamo is called *paragone*, from its black color, like touchstone; it

has a pure intense tint, and is susceptible of a fine polish. The pure black marble of Como is also much esteemed. The *polveroso* of Pistoya, is a black marble sprinkled with dots; and the beautiful white marble with black spots, from the Lago Maggiore, has been employed for decorating the interior of many churches in the Milanese. The Margorre marble found in several parts of the Milanese, is bluish veined with brown, and composes part of the dome of the cathedral of Milan. The green marble of Florence owes its color to a copious admixture of steatite. Another green marble, called *verde di Prado*, occurs in Tuscany, near the little town of Prado. It is marked with spots of a deeper green than the rest, passing even into blackish-blue. The beautiful Sienna marble, or *brocatello di Siena*, has a yellow color like the yolk of an egg, which is disposed in large irregular spots, surrounded with veins of bluish-red, passing sometimes into purple. At Montarenti, two leagues from Sienna, another yellow marble is met with, which is traversed by black and purplish-black veins. The Brema marble is yellow with white spots. The *mandelato* of the Italians is a light red marble with yellowish-white spots, found at Luggezzana, in the Veronese. The red marble of Verona is of a red rather inclining to yellow or hyacinth; a second variety of a dark red, composes the vast amphitheatre of Verona. Another marble is found near Verona, with large white spots in a reddish and greenish paste. Very fine columns have been made of it. The *occhio di pavone* is an Italian shell marble, in which the shells form large orbicular spots, red, white, and bluish. A madreporic marble, known under the name of *pietra stellaria*, much employed in Italy, is entirely composed of star madrepores, converted into a gray and white substance, and is susceptible of an excellent polish. The village of Bretonico, in the Veronese, furnishes a splendid breccia marble, composed of yellow, steel-gray, and rose-colored spots. That of Bergamo consists of black and gray fragments in a greenish cement. Florence marble, called also ruin and landscape marble, is an indurated calcareous marl.

Sicily abounds in marbles, the most valuable of which is that called by the English stone-cutters, Sicilian jasper; it is red with large stripes like ribands, white, red, and sometimes green, which run zigzag with pretty acute angles.

Among the Genoese marbles we may notice the highly esteemed variety called *portor*, on account of the brilliant yellow veins in a deep black ground. The most beautiful kind comes from Porto-Venese, and Louis XIV. caused a great deal of it to be worked up for the decoration of Versailles. It costs now two pounds per cubic foot.

Of cutting and polishing marble.—The marble saw is a thin plate of soft iron, continually supplied during its sawing motion, with water and the sharpest sand. The sawing of moderate pieces is performed by hand, but that of large slabs is most economically done by a proper mill.

The first substance used in the polishing process is the sharpest sand, which must be worked with till the surface becomes perfectly flat. Then a second, and even a third sand of increasing fineness is to be applied. The next substance is emery of progressive degrees of fineness, after which tripoli is employed; and the last polish is given with tin-putty. The body with which the sand is rubbed upon the marble, is usually a plate of iron; but for the subsequent process, a plate of lead is used with fine sand and emery. The polishing rubbers are coarse linen cloths, or bagging, wedged tight into an iron planing tool. In every step of the operation, a constant trickling supply of water is required.

Visitors of Derby may have an opportunity of inspecting Brown's extensive machinery for cutting marble into many ornamental forms, which has been well described in Rees' Cyclopedia.

Sir James Jelf patented, in 1822, a combination of machinery for cutting any description of parallel mouldings upon marble slabs, for ornamental purposes; in which, tools, supplied with sand and water, are made to traverse to and fro.

Mr. Tullock obtained a patent, in 1824, for improvements in machinery for sawing and grooving marble; the power being applied by means of toothed wheels bearing cranks, which gave the see-saw motion to the cutting iron plates.

In November, 1829, Mr. Gibbs secured, by patent, an invention for working ornamental devices in marble, by means of a travelling drill, guided by a mould of wood, &c., in counter relief; and in April, 1833, Mr. G. W. Wilds obtained a patent for machinery, which consists of a series of circular cutters, for separating slabs from a block of marble; the block being advanced slowly to meet the cutters, by the progressive movement of a platform upon wheels, driven by the agency of a rack and pinion, as in the cylinder boring machine of the steam-engine manufacturer. Sand and water must be supplied, of course, from a hopper, to these smooth cutting dises of iron or copper. He proposes also to mould and polish marble, by applying a rotatory wheel or cylinder ofany shape to it, in its carrying frame.

NEW APPLICATIONS OF THE ELECTROTYPE.

Letter from M. Perrot to M. Arago.

I have just learned, through a journal, that M. Sorel has announced to the Academy of Sciences, that he has been enabled by means of a constant current, to fix, without heat, on iron, a more or less thick and very adherent layer of zinc, and that by this means he has been able to fix several metals on one another.

Consequently I thought it my duty immediately to send to the Institute, to be deposited there, some objects hastily collected, which remained from experiments, which I made more than a year ago, on metallic precipitations.

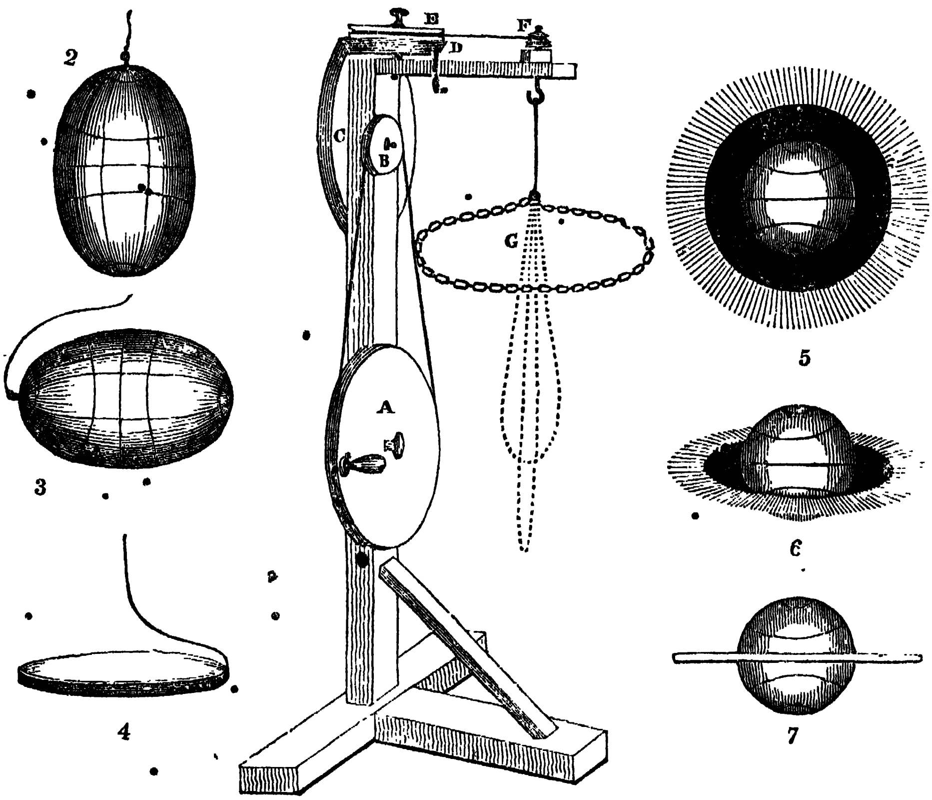
Among the objects contained in the box which I send, there are some experiments on a process of metallic incrustation, which I consider new, and capable of receiving many applications in the arts. I obtained these incrustations by means of galvanic currents, by precipitating a metal of one color, in the parts corroded, by a process analogous to that of engraving by nitric acid, on a metallic piece of another color.

Thus, as it was easy to foresee, the incrustations have all the perfection of the engraving, which serves as a mould, and the imperfection of the incrustation which I send you does not extend to that of the new galvanic methods which I wished to try in engraving.—*Comptus Rendus.*

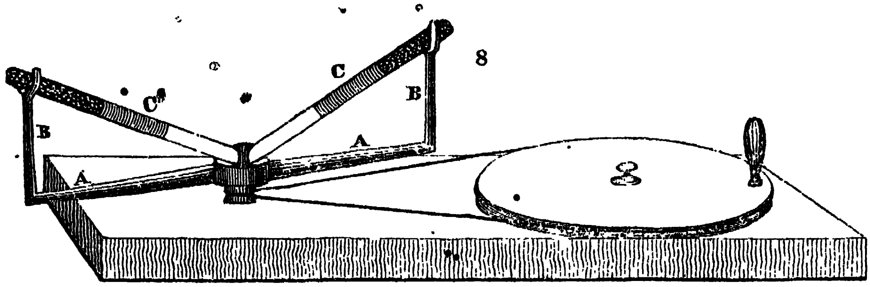
London:—Printed by D. Francis, 6, White Ho[illegible]

[illegible]shed by W. Brittain, 11, Paternoster Row.

Fig. 1.

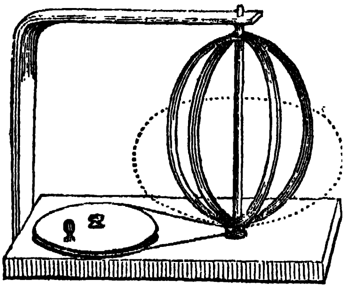


MACHINE TO PROVE THE SHAPE OF THE EARTH.



MACHINE TO PROVE THE SHAPE OF THE EARTH.

We are taught that the earth is round, but flattened towards the poles like an orange. The mathematical proofs of this are too tedious to be interesting to general readers; yet, there remain others of a mechanical nature, which acting by the same cause, namely, centrifugal force, establish the same fact experimentally. One machine for this purpose is usually called the centrifugal hoops, which is represented as follows:—



It consists of two hoops of tin, fastened at bottom to an upright spindle, which is turned by a pulley and multiplying wheel; as soon as the wheels are made to revolve rapidly their general elongated shape will be altered, and centrifugal force acting upon the equatorial parts of the hoops will occasion them to bulge out towards that part, and to become compressed at the top and bottom. Were there any greater number of hoops the effect would be of a similar kind, but still more conspicuous than with two. In this machine, the stand, wheel, and support may be dispensed with, the spindle of the hoops being turned round by the hands. The above machine shows that a revolving body therefore, if of a yielding substance, accommodates its form according to the degree of centrifugal force which it attains; and as this force is dependent upon the rapidity of motion, it follows, that the more rapidly such a body revolves, the more flattened it will become. Were the earth of a similarly yielding texture, the above would be a sufficient explanation of the earth's shape, but it is not so to the extent that is requisite, for although the waters are fluent, yet the solid earth is incapable of moving from its place. We must, therefore, next direct our attention to the effect of centrifugal force upon unyielding substances; for this purpose, and indeed for experiments upon bodies of any kind, the machine, No. 1, is well adapted. It is formed of wood, painted black, (as the frame-work of all astronomical apparatus ought to be.) The multiplying wheel A turns the pulley B, the axis of which, also forms the axis of the brush wheel C, and which consequently partakes of its motion. The edge of C working against the edge of D, turns that wheel round with increased velocity—a band proceeding from D to F continues the motion to the hook connected with and below F. Now it is evident that motions being given to the wheel A, it will be continued to the hook, increasing in rapidity at every stage of its progress. Suppose that we have formed a representation of the earth, of a shape corresponding to the oblong spheroid, Fig. 2, and we suspend this by a string to the hook. Putting it in rapid motion, it will be found impossible to continue its rotation, even for a minute, without the spheroid altering its position, and taking that of Fig. 3, or in other words, revolving on its shorter axis.

We may even take a flat circular piece of board, and although the axis across it may be a foot, and that of the thickness not more than half an inch, yet, the same result will be obtained, the disc becoming horizontal, and retaining that position during the whole time of its revolution, or at least, as long as the rapidity of its motion is maintained.

The planet Saturn affords a still more striking example. Let the model be made of a solid ball of wood, three inches in diameter, furnished with a ring of tin, to represent Saturn's ring; let the centre part of the ring be painted black, and a hole made near the extremity for a string to be tied to it; suspend the model by this string to the hook, and occasion it to revolve, when the model will soon assume all the forms and appearances which the planet itself puts on, in reference to the views we are capable of obtaining of it at different times of our respective revolutions. In one position, the ring being a conspicuous and beautiful object, far distant from the body of the planet, then gradually becoming in appearance narrower, until it seems only as a bright line across the planet's face, and beyond it, on each side. See Fig. 5, 6, & 7.

A chain suspended from the hook is an excellent illustration of the effects of centrifugal force; first, it hangs in a loose collapsed manner, then it gradually widens, until at length it forms a ring which revolves horizontally.

The machine, Fig. 8, is usually called *the whirling table.* The foot-board supports a multiplying wheel, and small upright spindle, which is turned round by this wheel. The upright spindle is very short, and intended merely to support the cross arms A A. Upon the ends of A A are two uprights B B, to support the upper ends of two glass tubes C C. The glass tubes are closed at both ends, and partly filled with shots, and sometimes with shots and water, so as to leave equal spaces of shot, water, and air. If a rapid motion be communicated to the cross arms, of course, centrifugal force will cause the substances to fly out away from the centre, and contrary to the position that gravity alone would place them in. The shots, therefore, would leave the lower part of the tubes, and fly towards the farther ends; and if the tubes be long, and the motion communicated to them be very rapid, such will be the power acquired, that the outer ends of the tubes will, in all probability, be broken, or if left open, the shots will be scattered to a very considerable distance.

Now what do these experiments teach us? Why first, that if the earth revolves at all, and of which there is no doubt, although it is difficult to bring forward a positive proof that it does, it must necessarily revolve on its shortest axis. Secondly, that to have assumed its spheroid form, it must either have been made so at first, (of which there is no proof) or that it must at some former time have been sufficiently fluid to have yielded to the centrifugal influence, and like the chain or the hoops have accommodated itself to the shape, which its rotatory force must have induced; and thirdly, we must admit that the same power which at a former time influenced the now solid parts, have still an effect upon the waters, tending to draw them from the polar regions towards the equator, until at length, the centrifugal and centripetal forces balancing each other, they assume a shape proportionably convex

yet restrained from further alteration both by the force of gravity and the pressure of the atmosphere.

ELECTRICITY FROM STEAM.

On Saturday, the 19th December, Mr. Condie, manager of Blair Iron Works, Ayrshire, performed this new and interesting phenomenon at the above works, in the presence of Ludovic Houston, Esq., of Johnstone; — Cunningham, Esq., of Carnbrae Iron Works; Thomas Wingate, Esq., engineer; Springfield, and a number of others, who were all highly satisfied with the accuracy of the accounts given by the public press of similar experiments having been made in the neighbourhood of Newcastle, upon locomotive engine boilers. The experiment made by Mr. Condie was upon the steam issuing from the safety valve of two of the high pressure boilers of the blowing engine, and was simply performed as follows:—

The experimenter placed himself upon an insulated stool (a board resting upon three quart bottles in absence of better,) and having in one hand a long small rod of iron, with four sharpened points, similar to a lightning conductor; this he held in the steam issuing from the safety valve. When the points were held about one foot from the valve, electric sparks were drawn by the bystanders' knuckles from those of the experimenter about half an inch long; but as the pointed rod was raised to about six or eight feet above the valve into the cloud of steam, vivid and pungent sparks were then drawn from one and a half to two inches long, which, in fact, were nearly as stunning upon the arm as the shocks of a small Leyden phial, producing a good deal of merriment to the astonished workmen who were present, to see fire and feel the shocks from steam, an article they all supposed themselves perfectly familiar with.

In the evening the experiment was resumed, to see the effects in the dark, when they proved the experimenter to be highly charged with electricity. The board on which he stood, not being rounded, each corner had a brush of light two or three inches long, like as many tassels, while every point of his dress and hair became highly luminous upon the persons standing near him. On this trial, sparks were drawn fully two inches long, which required some little courage to engage with, from their shocking propensities.

The experiments were made upon the steam of two boilers, thirty-two feet long by six diameter, first with steam equal to 12 ℔. upon the inch, and latterly at 25 ℔.—the increase of pressure adding to the effect. However, the experiment was perfectly and satisfactorily performed with the surplus steam issuing from the safety valve while the engine was going upon trial. Mr. Condie is of opinion that, from such boilers, with a properly constructed prime conductor, of large surface, sparks may be drawn from six to eight inches long, and large jars charged in a few seconds. The wonder was that the experiment succeeded at all, as the apparatus was altogether rude. The floor where the temporary stool stood was covered with dust, shavings, &c., which acted as conductors in stealing away the electricity from the experimenter.—*Ayr Observer.*

WAVES.

The common cause of waves is the friction of the wind upon the surface of the water. Little ridges or elevations first appear, which by continuance of the force, gradually become loftier and broader, until they are the rolling mountains seen where the winds sweep over a great extent of water. The heaving of the Bay of Biscay, or still more remarkably, of the open ocean beyond the southern capes of America and Africa, exhibits one extreme, and the stillness of the tropical seas, which are sheltered by near encircling lands, exhibits the other. In the vast Archipelago of the East, where Borneo, and Java, and Sumatra lie, and the Molucca islands and the Philippines, the sea is often fanned only by the land and sea breezes, and is like a smooth bed, in which these islands seem to repose in bliss—islands in which the spice and perfume gardens of the world are embowered, and where the bird of paradise has its home, and the golden pheasant, and a hundred other birds of brilliant plumage, among thickets so luxuriant, and scenery so picturesque, that European strangers find there the fairy land of their youthful dreams. —One who has visited these islands in his early days may perhaps be pardoned for thus adverting to their beauties.

In rounding the Cape of Good Hope, waves are met with, or rather a swell, so vast, that a few ridges and a few depressions occupy the extent of a mile. But these are not so dangerous to ships as what is termed a *shorter* sea, with more perpendicular waves. The slope in the former is comparatively gentle, and the rising and falling are much less felt; while among the latter, the sudden tossing of the vessel is often destructive. When a ship is sailing directly before the wind, over the *long swell* now described, she advances as if by leaps; for as each wave passes, she is first descending headlong on its front, acquiring a velocity so wild that she can scarcely be steered; and soon after, when it has glided under her, she appears climbing on its back, and her motion is slackened almost to rest, before the following wave arrives. To a passenger perched at such a time on the extremity of the bowsprit, and looking back on the enormous body of the ship, with perhaps its thousand of a crew, a hundred feet behind him, heaved by these billows as a cork is on a ruffled lake, the scene is truly sublime. When a coming wave lifts the stern, and in the same degree depresses the bow, he is deep in the hollow or valley between the waves, and sees only the ship rushing headlong down towards him as if to be ingulphed; but soon after, when the stern is down, and the bow is raised, he looks from his station in the sky upon an awful scene beneath him and around.

The velocity of waves has relation to their magnitude. The large waves just spoken of, proceed at the rate of from thirty to forty miles an hour. It is a vulgar belief that the water itself advances with the speed of the wave, but in fact the *form* only advances, while the *substance*, except a little spray above, remains rising and falling in the same place, with the regularity of a pendulum. A wave of water, in this respect, is exactly imitated by the wave running along a stretched rope when one end is shaken; or by the mimic waves of our theatres, which are generally undulations or long pieces of carpet, moved by attendants. But when a wave reaches a shallow bank or beach, the water becomes really progressive, for then, as it cannot sink directly downwards, it falls over and forwards, seeking the level.

So awful is the spectacle of a storm at sea, that

it generally biasses the judgment; and, lofty as waves really are, imagination pictures them loftier still. Now no wave rises much more than ten feet above the ordinary sea-level, which, with the ten feet that the surface afterwards descends below this, give twenty feet for the whole height, from the bottom of any water-valley to an adjoining summit. This is easily verified by a person who tries at what height on a ship's mast the horizon remains always in sight over the top of the waves—allowance being made for accidental inclinations of the vessel, and for her sinking in the water to considerably below her water line, at the time when she reaches the bottom of the hollow between the two waves. The spray of the sea, driven along by the violence of the wind, is of course much higher than the summit of the liquid wave; and a wave coming against an obstacle, or entering a narrowing inlet, may dash to an elevation much greater still. At the Eddystone light-house, which is about ninety feet high, placed on a solitary rock ten miles from the land, when a surge breaks which has been growing under a storm all the way across the Atlantic, it often dashes to 100 feet above the lantern at the summit.

The magnitude of waves is well judged of when they are seen breaking on an extended shore or beach. In the deep sea the wave is only an elevation of the water, sloping on either side; but as it rolls towards the shore, its front becomes more and more perpendicular, until at last it curls over and falls with its whole weight, and when several miles of it break at the same instant, its force and noise may shake the country around.

Along the east, or Coromandel Coast of India, at certain seasons, vast waves are constantly breaking; and as there are no good harbours there, communication between the sea and land is rendered impossible to ordinary boats. The natives of the coast, at Madras, for instance, have hence become almost amphibious. They reach ships beyond the breakers by the help of what are called *catamarans*, consisting of three small logs of wood tied together. On these they secure themselves, and boldly advance up to the coming wall of water, which they shoot into, and rise to the smooth surface beyond it, like water-fowls after diving. Boats unsuited to the breakers often perish in them. The Author had gone on shore with a watering party on the coast of Sumatra, and during the hours spent there, a swell had arisen in the sea, which on their return was already bursting along the beach and across the river's mouth in lofty breakers. The boat in which he happened to be, regained the high sea in safety, but a larger boat which followed at a short distance was overwhelmed, and an officer and part of the crew perished.

There is a phenomenon observed at the mouths of many great rivers, called the *Boar*, which has resemblance to a wave. When the tide returning from the sea meets the outward current of the river, and both have the force which in certain situations belong to them, the stronger mass from the ocean assumes the form of an almost perpendicular wall, moving inland with resistless sweep. This is called the boar. It is in fact the great sea-wave of the tide, produced twice a day by the attraction of the moon, rolling in upon the land and inlets, where contracting channels concentrate its mass. In the different branches of the Ganges the boar is seen in a remarkable degree. Its roaring is heard long before it arrives. Smaller boats and skiffs cannot live where it comes; and as it passes the city of Calcutta, even the large ships at anchor there are thrown into such commotion, as sometimes to be torn away from their moorings. The nature and effects of this boar are strikingly illustrated upon certain coasts where extensive tracts of sand are left uncovered at low water. In such situations, of which there are many on the western shores of Britain, the returning tide is seen advancing with steep front, and with such rapidity, that the speed of a galloping horse can scarcely save a person who has incautiously approached too near. Many, every year, are the victims of temerity or ignorance on these treacherous plains.

In the end of the year 1831, on the low flat coast of the Indian peninsula, north of Madras, one great wave of the kind now described was produced during a very high spring-tide of midnight, by an extraordinary wind, and spread ten miles in upon the inhabited land. It had retired with the ebbing tide before morning, but the next day's sun disclosed a scene of devastation rarely matched. Amidst the total wreck of the villages and fields, there lay the drowned carcases of more than ten thousand human beings, mixed with those of elephants, horses, bullocks, wild tigers, and the other inhabitants of the land.

It has been proposed lately to construct *submarine boats*, or vessels calculated to swim so deep in the water as to be below the superficial motion of the waves, and therefore beyond the influence of storms at the surface. Such a boat has been tried with considerable success; and men's increasing familiarity with sub-marine matters since the invention of the diving-bell, may ultimately lead to improvements, rendering the sub-marine vessel, for certain purposes, commodious and safe.

DR. ARNOTT.

ELECTRO-MAGNETIC CLOCK,

BY PROFESSOR WHEATSTONE.

A Paper read by him at the last Meeting of the Royal Society.

THE object of the apparatus, forming the subject of this communication, is stated by the author to be that of enabling a single clock to indicate exactly the same time in as many different places, distant from each other, as may be required. Thus, in an astronomical observatory, every room may be furnished with an instrument, simple in its construction, and therefore little liable to derangement, and of trifling cost, which shall indicate the time, and beat dead seconds audibly, with the same precision as the standard astronomical clock with which it is connected; thus obviating the necessity of having several clocks, and diminishing the trouble of winding up and regulating them separately. In like manner, in public offices and large establishments, one good clock will serve the purpose of indicating the precise time in every part of the building where it may be required, and an accuracy ensured which it would be difficult to obtain by independent clocks, even putting the difference of cost out of consideration. Other cases in which the invention might be advantageously employed were also mentioned. In the electro-magnetic clock, which was exhibited in action in the apartments of the society, all the parts employed in a clock for maintaining and regulating the power are entirely dispensed with. It consists simply of a face with its second, minute and hour hands, and of a train of wheels which communicate motion from the arbor of the second's hand to that

of the hour hand, in the same manner as in ordinary clock trains; a small electro-magnet is caused to act upon a peculiarly constructed wheel (scarcely capable of being described without a figure) placed on the second's hand, advances a sixtieth part of its revolution. It is obvious, then, that if an electric current can be alternately established and arrested, each resumption and cessation lasting for a second, the instrument now described, although unprovided with any eternal maintaining or regulating power, would perform all the usual functions of a perfect clock. The manner in which the apparatus is applied to the clocks, so that the movements of the hands of both may be perfectly simultaneous is the following. On the axis which carries the scape-wheel of the primary clock, a disc of brass is fixed, which is first divided on its circumference into sixty equal parts; each alternate division is then cut out and filled with a piece of wood, so that the circumference consists of thirty regular alternations of wood and metal. An extremely light brass spring, which is screwed to a block of ivory or hard wood, and which has no connexion with the metallic parts of the clock, rests by its free end on the spring, and proceeds to one end of the wire of the electro-magnet; while another wire attached to the clock-frame is continued until it joins the other end of that of the same electro-magnet. A constant voltaic battery, consisting of a few elements of very small dimensions, is interposed in any part of the circuit. By this arrangement the circuit is periodically made and broken, in consequence of the spring resting for one second on a metal division, and the next second on a wooden division. The circuit may be extended to any length; and any number of electro-magnetic instruments may be thus brought into sympathetic action with the standard clock. It is only necessary to observe, that the force of the battery and the proportion between the resistances of the electro-magnetic coils and those of the other parts of the circuit, must, in order to produce the maximum effect with the least expenditure of power, be varied to suit each particular case.

ANTISEPTIC PROPERTIES OF PEAT.

One interesting circumstance attending the history of peat-mosses is the high state of preservation of animal substances buried in them for periods of many years. In June, 1747, the body of a woman was found six feet deep, in a peat-moor in the Isle of Axholm, in Lincolnshire. The antique sandals on her feet afforded evidence of her having been buried there for many ages: yet her nails, hair, and skin, are described as having shown hardly any marks of decay. On the estate of the Earl of Moira, in Ireland, a human body was dug up, a foot deep in gravel, covered with eleven feet of moss; the body was completely clothed, and the garments seemed all to be made of hair. Before the use of wool was known in that country, the clothing of the inhabitants was made of hair, so that it would appear that this body had been buried at an early period; yet it was fresh and unimpaired. In the Philosophical Transactions, we find an example recorded of the bodies of two persons having been buried in moist peat, in Derbyshire, in 1674, about a yard deep, which were examined twenty-eight years and nine months afterwards; "the color of their skin was fair and natural, their flesh soft as that of persons newly dead.'

Among other analogous facts we may mention, that in digging a pit for a well near Dulverton, in Somersetshire, many pigs were found in various postures, still entire. Their shape was well preserved, the skin, which retained the hair, having assumed a dry membranous appearance. Their whole substance was converted into a white, friable, laminated, inodorous, and tasteless substance; but which, when exposed to heat, emitted an odour precisely similar to broiled bacon.

Cause of the antiseptic property of peat.—We naturally ask whence peat derives this antiseptic property? It has been attributed by some to the carbonic and gallic acids which issue from decayed wood, as also to the presence of charred wood, in the lowest strata of many peat-mosses, for charcoal is a powerful antiseptic, and capable of purifying water already putrid. Vegetable gums and resins also may operate in the same way.

The tannin occasionally present in peat is the produce, says Dr. M'Culloch, of tormentilla, and some other plants; but the quantity he thinks too small, and its occurrence too casual, to give rise to effects of any importance. He hints that the soft parts of animal bodies, preserved in peat-bogs, may have been converted into adipocere by the action of water merely; an explanation which appears clearly applicable to some of the cases above enumerated.

Miring of Quadrupeds.—The manner, however, in which peat contributes to preserve, for indefinite periods, the harder parts of terrestrial animals, is a subject of more immediate interest to the geologist. There are two ways in which animals become occasionally buried in the peat of marshy grounds; they either sink down into the semifluid mud, underlying a turfy surface, upon which they have rashly ventured, or, at other times, a bog "bursts," and animals may be involved in the peaty alluvium.

In the extensive bogs of Newfoundland, cattle are sometimes found buried with only their heads and neck above ground; and after having remained for days in this situation, they have been drawn out by ropes and saved. In Scotland, also, cattle venturing on the "quaking moss," are often mired, or "laired," as it is termed; and in Ireland, Mr. King asserts that the number of cattle which are lost in sloughs is quite incredible.

Solway moss.—The description given of the Solway moss will serve to illustrate the general character of these boggy grounds. That moss, observes Gilpin, is a flat area, about seven miles in circumference, situated on the confines of England and Scotland. Its surface is covered with grass and rushes, presenting a dry crust and a fair appearance; but it shakes under the least pressure, the bottom being unsound and semifluid. The adventurous passenger, therefore, who sometimes in dry seasons traverses this perilous waste, to save a few miles, picks his cautious way over the rushy tussocks as they appear before him, for here the soil is firmest. If his foot slip, or if he venture to desert this mark of security, it is possible he may never more be heard of.

"At the battle of Solway, in the time of Henry VIII., (1542,) when the Scotch army, commanded by Oliver Sinclair, was routed, an unfortunate troop of horse, driven by their fears, plunged into this morass, which instantly closed upon them. The tale was traditional, but it is now authenticated; a man and horse, in complete armour, having been found by peat-diggers, in the place where it was

always supposed the affair had happened. The skeleton of each was well preserved, and the different parts of the armour easily distinguished."

This same moss, on the 16th of December, 1772, having been filled with water during heavy rains, rose to an unusual height, and then burst. A stream of black half-consolidated mud began at first to creep over the plain, resembling, in the rate of its progress, an ordinary lava current. No lives were lost, but the deluge totally overwhelmed some cottages, and covered four hundred acres. The highest parts of the original moss subsided to the depth of about twenty-five feet; and the height of the moss, on the lowest parts of the country which it invaded, was at least fifteen feet.

Bursting of a peat-moss in Ireland.—A recent inundation in Sligo, (January, 1831,) affords another example of this phenomenon. After a sudden thaw of snow, the bog between Bloomfield and Geevah gave way; and a black deluge, carrying with it the contents of a hundred acres of bog, took the direction of a small stream, and rolled on with the violence of a torrent, sweeping along heath, timber, mud, and stones, and overwhelming many meadows and arable land. On passing through some boggy land, the flood swept out a wide and deep ravine, and part of the road leading from Bloomfield to St. James's Well was completely carried away from below the foundation for the breadth of two hundred yards.

Bones of herbivorous quadrupeds in peat.—The antlers of large and full-grown stags are amongst the most common and conspicuous remains of animals in peat. They are not horns which have been shed; for portions of the skull are found attached, proving that the whole animal perished. Bones of the ox, hog, horse, sheep, and other herbivorous animals also, occur; and in Ireland and the Isle of Man, skeletons of a gigantic elk. M. Morren has discovered in the peat of Flanders, the bones of otters and beavers; but no remains have been met with belonging to those extinct quadrupeds of which the living congeners inhabit warmer latitudes, such as the elephant, rhinoceros, hippopotamus, hyæna, and tiger, though these are so common in superficial deposits of silt, mud, sand, or stalactite, in various districts throughout Great Britain. Their absence seems to imply that they had ceased to live before the atmosphere of this part of the world acquired that cold and humid character which favors the growth of peat.

Remains of ships, &c., in peat-mosses.—From the facts before mentioned, that mosses occasionally burst, and descend in a fluid state to lower levels, it will readily be seen that lakes and arms of the sea may occasionally become the receptacles of drift-peat. Of this, accordingly, there are numerous examples; and hence the alternations of clay and sand with different deposits of peat so frequent on some coasts, as on those of the Baltic and German Ocean. We are informed by Deguer that remains of ships, nautical instruments, and oars, have been found in many of the Dutch mosses; and Gerard, in his History of the Valley of the Somme, mentions that in the lowest tier of that moss was found a boat loaded with bricks, proving that these mosses were at one period navigable lakes and arms of the sea, as were also many mosses on the coast of Picardy, Zealand, and Friesland, from which soda and salt are procured. The canoes, stone hatchets, and stone arrow-heads, found in peat in different parts of Great Britain, lead to similar conclusions.

PAPYROGRAPHY.

This is a new invention for re-producing drawings, manuscripts, and all kinds of designs to an unlimited extent, and by means much cheaper than at present known. This process, which is called by M. de Manne, the inventor, *Papyrography*, is very fully noticed in a late number of the *Moniteur*, from which we abridge the following particulars:—The mode by which M. de Manne produces designs, &c., on paper, is thus described. After having, by means of his prepared metallic ink, traced the drawing on common writing paper, he contrives, by an operation which he at present keeps secret, to make the lines rise from the paper in relief, and become extremely hard and durable. He fixes this matrix on a plate of metal, on which he then places the paper that is to receive the impression. Over the paper he places a piece of silk, and passes it under the roller of a copper-plate press; when the characters and lines on the manuscript or drawing are re-produced, stamped in on the paper. These designs thus fixed on the plates are hard enough to allow of a greater number of impressions being taken without injury to them. The part of the invention, which consists in obtaining plates of metal cast from the matrix afforded by the drawing on the paper, is considered by the committee of the Society of Arts of Mulhausen, who were appointed to examine it, as of still greater importance than any other. By this engraving on paper, say the committee, may be obtained impressions fully equal to what can be had from wood engravings; by this means, therefore, works which require illustrations may be printed with great cheapness. In engravings on wood, the design and the subsequent cutting are necessary, but by the papyrographic method, the design is the only expense; and it will produce without end as many engraved plates and impressions as may be required, at a cost one half of that of the ordinary process; and with a precision equal to that of the original drawing. As M. de Manne conducted his experiments at Rouen, where there was no skilful metal founder, he labored under great disadvantage in his attempts to bring his invention to perfection, but the specimens he sent to the committee were sufficient to convince them that his plan was capable of answering all that he stated. Some of the specimens sent to the committee presented the designs, and the printed copies from them in relief to the height of from two to three millimetres, obtained solely from the matrix traced on paper. The committee propose to extend the invention to the printing of woven fabrics and paper. M. de Manne sent some plates prepared for this object, but owing to the disadvantages under which he labored, the plates were not so perfectly cast as they ought to have been, to produce the desired effect. The defect, however, he ascribes entirely to the unskilful manner in which the Rouen founders took the cast of his matrices; for not venturing to trust them with the paper moulds, he took casts of them in plaster; from which the metal plates were afterwards cast. It is to this circumstance that M. de Manne attributes the failure of his experiment, as it was difficult to take the cast in plaster from the paper so as to preserve the sharpness of the outline. He says he is certain of the success of his process, as applied to the printing of papers and calicoes, but want of means with him, as with many other inventors, prevents him from taking out patents, or from carrying the invention into operation. The

committee report that it seems to them highly probable that if the inventor was placed in more favorable circumstances, he would arrive at remarkable and very useful results. In conclusion, they recommend the society to grant him a silver medal, though the invention is not of a nature within their usual subjects for prizes.—*Inventors' Advocate.*

FRENCH MANUFACTURE OF INDIA-RUBBER WEB.

THE fabric of India-rubber web was commenced at Vienna, but much improved and extended in the manufactory at St. Denis, near Paris, in which there are about 1,500 of the machines for plaiting the thread around the filaments of the elastic gum, and all the other departments in correspondent proportion.

1st operation.—The gum elastic is provided in the usual form of bottles. The first operation is to divide these bottles into two equal parts; they are then placed in piles of six or eight in height, and of an indefinite number in extent, upon a plank, and another plank is placed upon them, when the two are drawn together by wooden screws and nuts. They remain in this state a sufficient time to render them flat, or to take out in a great measure the original curvature of the bottles.

2nd operation.—The first machine contains a circular knife which revolves rapidly, its diameter being about eight inches. At the side of its edge is an advancing carriage or slide, which receives its movement by means of a screw from the shaft of the knife. Upon this slide is attached the gum, a hole being made in its centre to receive a screw, which serves as a pivot upon which it may turn; it is held down by a nut that is screwed upon it, and the edges are held down by springs placed near to the knife, but not so strong as to prevent its turning under them. A box under the table contains water, in which the knife runs, and a box above it incloses the blade, and prevents the water from being thrown into the face of the workman. When the machine is started, the gum advances and is turned round by hand, whilst the knife cuts off the irregular circumference, until a continuous slip comes off, which the workman takes hold of and draws away, the carriage advancing, and the knife cutting until the gum is exhausted. The operation resembles the cutting of leather strings out of circular pieces of that material, in the manner practised in the olden time by shoe-makers.

3rd operation.—These slips pass into a bucket of water, from which they are taken and examined through their whole length by a woman, who removes the defective parts, and joins together the ends of the slips, by cutting them off in a sloping direction, and making a nick near the extremities, with a pair of scissors. These ends are then placed together, and hammered with some force upon an anvil, by which means they are made to adhere with considerable tenacity.

4th operation.—These slips thus joined pass to another engine, which resembles in almost all respects the slitting mills of iron works, of a size proportionate to the material upon which they operate. The slip, always contained in water, is guided into this cutting mill, which has five or six blades according to the width of the slip, and is kept in its place, and prevented from turning by a slight spring. After passing between the cutters, it is drawn off by two rollers, between which it passes, and from thence into the hands of the attendant, who passes the slip thus divided into threads, into water.

5th operation.—The filaments then pass into the hands of females, who examine them through their whole extent, remove the imperfect parts, and join the extremities as before.

6th operation.—The next machine is important, having for its object to remove the elasticity of the gum, or in other words, to stretch the filaments to their utmost extent. It consists of a reel of eighteen or twenty inches in diameter, revolving with considerable rapidity. Between the attendant and the reel is a wheel with several grooves of different diameters, revolving with a movement slow compared to that of the reel, and which has a transverse movement from the right to the left side, thus serving as a guide to the filament, and preventing it from overlapping upon the reel. This latter wheel was evidently intended to give an equal tension to the gum, as it was wound upon the reel, but the filament was simply held by the hand, and the wheel only used as a guide; sufficient practice on the part of the workman giving to the motion every desirable regularity. The slips are left upon these reels to dry and harden for a period varying from three to six weeks.

7th operation.—They are then wound upon bobbins by the usual means of a wheel and spindle, by a woman, care being taken to retain the tension.

8th operation.—The next operation is the plaiting of silk, cotton, thread, or other material, around the filament of gum, previously colored or white, according to the objects into which it is subsequently to be manufactured. This is performed by an extremely ingenious machine, the construction of which it would be impossible to illustrate without drawings; the machines are manufactured, and for sale in Paris, by Blanchin, No. 98, Rue Faubourg, St. Martin. They have the important quality of stopping, if a thread breaks or is exhausted.

9th operation.—The machine last alluded to, draws the filament off the bobbins upon which it was previously wound, and after plaiting around it, winds it again upon others, which when filled, are conveyed to the looms, and there placed in frames, with a strap and counter-weight to give the necessary tension, and in sufficient number to form the warp of the web, which of course varies in width according to the object to which it is destined. The looms were usually simple and moved by hand, but there are also looms capable of weaving six webs or more at the same time, the shuttles of which are furnished with racks, by means of which they are carried through the chain.

The plaited filament is combined with silk or other matter, and filled with different materials, according to the object of the manufacturer, and in this respect, all the variety of the weaver's art may be exercised.

All the operations thus far noticed, have been performed by machinery, driven by a steam-engine, with the exception of the looms, which it appears are not necessarily excepted. In most of them the gum has been deprived of its elasticity, the last operation consists in restoring this quality. This is effected by taking advantage of that well-known, though extraordinary character which gum elastic possesses, of shrinking by the application of heat.

10th operation.—The machine to effect this is a long table covered with coarse cloth or felting in

several thicknesses; at each end is a shaft crossing it from one side to the other, upon which are pulleys —a strap passes over these pulleys, connecting the two ends of the table by a band, which has upon it a crotch. One of the shafts is furnished with a handle, to give motion to the whole. A heavy, square, smooth iron, heated to a convenient degree, is drawn by means of these straps from end to end; three or four webs are laid upon the table at one time, their extremities on the right are held by weights, whilst a light block lies upon them at the other extremity, keeping them flat, but not preventing their advancing as they shrink by the application of the heat of the iron; inclined planes near the ends lift off the weight at the close of the operation. The iron has wooden handles for convenient management. Baskets at one end, and boxes at the other, receive and supply the web.

The web shrinks in length as the heated iron passes over it, to about $\frac{2}{3}$ of the previous length, and has all its original elasticity restored. This operation closes the process, the web being subsequently prepared for sale by being made into rolls, and properly packed.

MISCELLANIES.

Inflammable Air from Alcohol.—Pelouze and Millon, by passing alcohol over anhydrous barytes, elevated to a dull red temperature, found that carbonate of barytes was formed, and carburetted hydrogen given off. This is the first instance in which this gas has been formed artificially; when formic acid is heated with an oxide it is decomposed into carbonic acid, which unites with the oxide, and into pure hydrogen. In this case, the half of the hydrogen comes from the water which has been decomposed by the carbon of the formic acid under the influence of potash. This action it occurred to the chemists mentioned, might also extend to alcohol. They passed carburetted hydrogen procured from alcohol over hydrate of barytes, and obtained hydrogen in large quantities. Naphthaline disengaged the same product. The anhydrous oxalates, when heated with barytes, afford, as is well known, carbonic oxide. By substituting hydrate of barytes, hydrogen is procured: carbonic oxide, also, under the same circumstances, affords pure hydrogen; even charcoal itself does the same. Pelouze and Millon have drawn the following conclusions: anhydrous barytes takes up from organic substances all the carbonic acid which their elementary composition permits them to furnish; hydrate of barytes extends the decomposition further, and tends to burn all the carbon, while the hydrogen which proceeds from the decomposition of the water is disengaged in a free state.

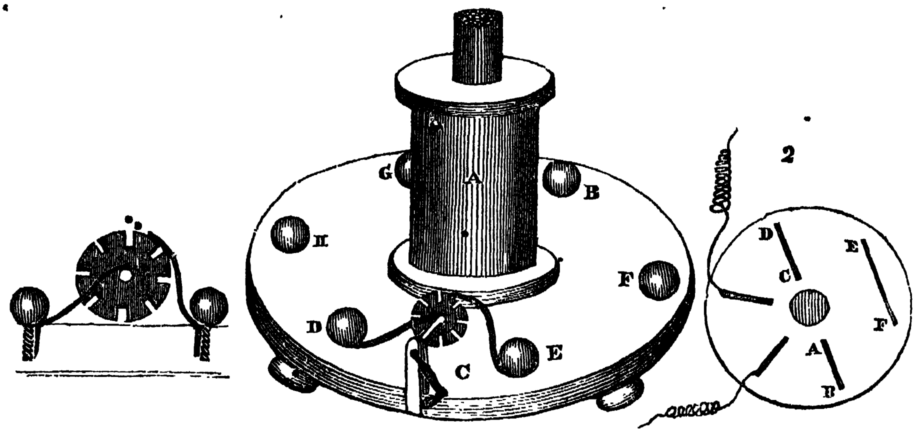
Electro-Vital Currents in Animals.—Zantedeschi and Favio state that in warm-blooded animals there exists an electro-vital or electro-nervous current in the cutaneous tissue, which passes continually from the extremities to the cerebro-spinal axis, and may be detected by means of the galvanometer. In the same animals there is an electro-vital current which passes from the cerebro-spinal axis to the internal organs placed under the skin. These currents are feebler in proportion to the weakening of the system. When death occurs, the currents are reversed. Pain weakens or suspends the electro-vital currents: voluntary movements or convulsions increase their strength.

Conversion of Fibrin into Albumen.—M. Letellier announces that he has succeeded frequently in performing successfully the experiment of Denis, viz. of converting fibrin into albumen, by boiling 46 grs. of fibrin well washed and pressed in 155 grs. of water, and 7 grs. of carbonate of soda, until the magma which the mixture formed has disappeared. This result is in accordance with the view broached by Dr. Thomson, of Glasgow, upwards of thirty years ago, that albumen owed its fluid state to the presence of soda.

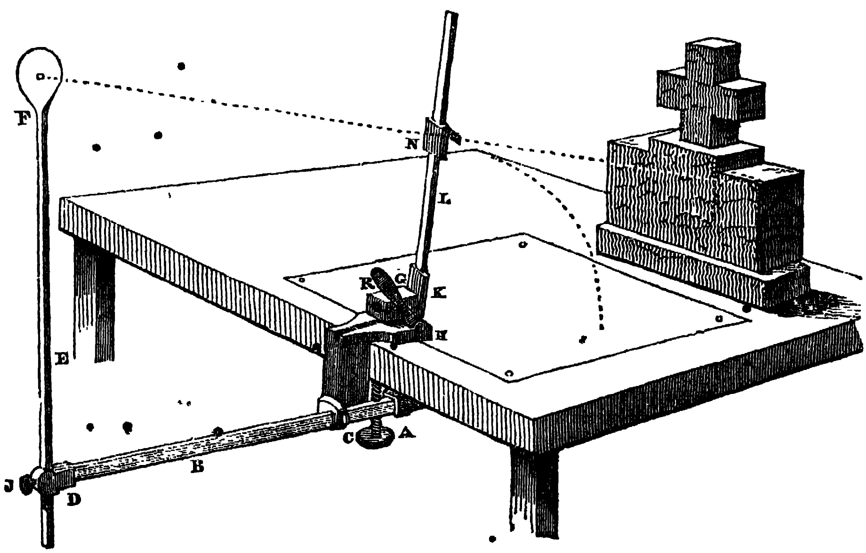
Moss on Gravel-walks.—A shaded gravel-walk in my garden was always covered with a mat of moss, and became perfectly green in the autumnal months. I watered it in parallel and transverse strips with solutions of different salts, to see whether any of them would destroy the moss and prevent its growing again. Several appeared to kill the moss, which, however, was re-placed in most cases in a very short time. I shall notice three of the solutions as having produced more permanent effects; these were, corrosive sublimate, sulphate of iron (green vitriol,) and sulphate of copper (blue vitriol.) The first two seemed to kill the moss immediately, but they also turned it black, and at the expiration of a year it was still adhering to the surface of the gravel, black instead of green. But the effect produced by the sulphate of copper was remarkable. The moss entirely disappeared, and at the end of the year, when the rest of the walk was again completely carpeted, the strip which had been watered with this solution was perfectly bare. My quitting Cambridge put an end to further observations. Perhaps this hint may induce some of your correspondents to take up the subject; and I should think it very probable that either the sulphate of copper or some other salt would be found very useful in keeping the walks of gardens in squares and other confined situations free from moss.—*Professor Henslow, in Gardener's Chron.*

Method of Zincing Copper and Brass.—M. Boettiger has succeeded in covering plates and wires of copper, brass, pins, &c., with a brilliant coating of zinc. His method is as follows: granulated zinc is prepared by pouring the fused metal into a mortar of heated iron, and stirring it rapidly with the pestle until it is solidified. The metal thus granulated is placed in a porcelain capsule, or in some other non-metallic vessel. A saturated solution of sal-ammoniac is poured over it; the mixture is boiled; the objects to be rendered white, are now placed in it, previously dipped in dilute hydrochloric acid: in a few minutes they are covered with a brilliant coating of zinc, which it is very difficult to remove by friction. The galvanic action is thus explained: the double chloride of zinc and ammonium formed is decomposed by the zinc and the plate of copper; the chlorine disengaged from the sal-ammoniac goes to the zinc; the ammonium is disengaged in the form of gas, and the undecomposed sal-ammoniac combines with the chloride of zinc to form the double chloride, a very soluble and easily decomposed salt. If then an excess of zinc exists in the solution in contact with the electro-negative copper, the salt is decomposed into its elements, and the reduced zinc is deposited on the negative copper.

Fig. 1.



WAGSTAFF'S ELECTRO-MAGNETIC MACHINE.



TURRELL'S PERSPECTOGRAPH.

WAGSTAFF'S ELECTRO-MAGNETIC MACHINE.

To the Editor.

Sir.—While I return you my sincere thanks for devoting a portion of your time and pages to my former communications, I presume to hope you will bestow a place on the present, as it is intended for the encouragement of those who are lovers of science, but fall back from their pursuit through the apparent impossibility of obtaining apparatus; to show them that their difficulties are not insurmountable if they would "set their shoulder to the wheel." I am a working man, and self-taught, and the following is a list of articles that I have made in my leisure hours, exclusive of a number of musical instruments, &c. Hydrometers, in various forms, horizontal sun dial, various camera obscuras, geographical time piece, perpetual almanack, foot-lathe with appendages, marine compass, electrical machines and variety of apparatus, magic lanthern, machine for cutting the teeth of wheels in the lathe, improved kaleidoscope, pneumatic apparatus, intermissive fountain, time piece moving three hands, seven primary planets, &c., time piece which shows the season, the month, the day of the month, and day of the week, the hour, day or night, and the length of the day, (original), an orrery, showing the sun's revolution on its axis, with nodes, the annual and diurnal revolutions of the earth, with inclined axis, the moon, with longitude, latitude, age, phases, &c., astronomical telescope, compound microscope, model of mechanical powers united, model of a small-ware loom, machines for covering wire, electro-magnetic machine, ditto, simplified.

The following is a description of the last-named article, which is simple in construction, looks neat, and answers very well:—

Fig. 1 is a stand, 8 inches diameter; on the top side are screwed six brass balls; in the centre stands the bobbin A, containing the coils, a tin tube, 1 inch wide and 5 long, with a bottom fitting into the bobbin, and the break wheel, turned by a small handle.

Both ends of each coil are brought to the bottom end of the bobbin, and go through to the under side of the stand, seen in Fig. 2. The inner end of the thick coil comes through at A, goes to the top at B, and is secured by the ball B, Fig. 1. The other end of the coil comes through at C, goes up at D, is secured by the ball D, and reaches to the centre of the break wheel, on the circumference of which rests the end of another wire, that goes under, and is secured by the ball E; it passes on the under side from E to F, the other end is secured at top by the ball F. The ends of the fine wire are secured by the balls G and H.

Fig. 3 shows how the balls are brought into contact with the wires, and how the ends of the wires rest on the break wheel, which is half an inch diameter, one quarter thick, with eight holes in the circumference, which pass under, and break contact with the end of the wire. To set the machine to work, a wire is twisted once or twice round the pole of the battery, and the other end round the ball B, and another wire from the outer pole to the ball F; the winch being turned, a spark is seen at the break. The handles for giving the shock are hooked, or otherwise connected, to the balls G and H. The strength of the shock is varied by the quantity of iron wires put into the tube. The coils consist of three-quarters of a pound each of Nos. 19 and 23 copper wire. Soldering is entirely dispensed with.

P. WAGSTAFF.

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TURRELL'S PERSPECTOGRAPH.

(From the Transactions of the Society of Arts.)

The foundation of this instrument is a brass clamp, having a screw at A to fix it to a table, drawing-board, &c.; to the lower part of this clamp two loops are attached, in which the bar B slides, and may be kept at any distance within its range by the binding screw C; the bar B has a loop fixed on one end, as shown at D, to receive a rod E, at the end of which is placed the sight piece F; this rod may be retained at any height by the screw J. To the upper part of the clamp two ears are attached, one of which is seen at H; between these the block G moves on an axis or taper pin, the end of which comes through the ear at H; the block G has an axis passing through it a little above, and exactly at a right angle to the taper pin before mentioned; and from the other projects the piece K, to receive the bar L, this bar may be turned from the right-hand to the left, and *vice versa*, retaining its position at any angle by the friction on the axis, which may be increased at pleasure, as the block which receives it is divided in two, the upper part being pressed upon the axis by a tightening screw. The slider N moves freely up or down, the bar L retaining itself in any situation by the pressure of two small springs enclosed within it pressing against the bar. The bar L, which is attached to the block by its axis, is kept in a perpendicular position by a spring pressing under the block, exactly in the same manner as the spring of a clasp-knife presses upon the square tongue or shoulder of the blade. The slider N has a projecting piece formed into a point, the end being used to make a coincidence with any part of the object to be drawn, and for the purpose of marking the perspective representation of that point upon the drawing, when the bar and slider are laid down upon the paper, and the point pressed upon by the finger, so as to make a small puncture. The handle R is for the purpose of elevating or depressing the bar and slider when they have been brought to any position desired, and prevent the accidental shifting of the bar, which might occur if the hand of the operator was to touch it in laying it down.

When the instrument is to be prepared for use, the brass block or joint G is to be fixed in the ears of the clamp by the axis, or pin H, upon which it turns. This part of the apparatus is then ready to be screwed to a table, drawing-board, &c., by the thumb-screw A. The paper upon which the drawing is to be made, may be fastened to the drawing-board on one side, by passing it under the clamp before it is screwed to the board or table, and the other sides may be confined by a few wafers, sealing wax, &c. The bar L, by the pressure of the spring under the brass block or joint, will stand perpendicular to the drawing-board, and may be turned either to the right or left, generating by such motion an imaginary plane, which is to be considered as the plane of the picture. The slider N may be moved up or down upon the bar, E, when it will be seen, that by the union of the two motions, namely, of the bar upon its axis I, and of the slider N upon the bar L, the small point fixed to the slider

may be placed anywhere in the supposed plane of the picture. The rod B is to be placed in the loops of the clamp, the eye-piece F fixed in it at any height or distance that may be considered most convenient for viewing the object to be drawn, and the instrument is ready for use.

When the instrument is to be used, the clamp must be screwed tight to a board or table, and the paper upon which the drawing is to be made, must be laid down close to the clamp, and fixed firmly with a few bits of soft wax. The pin, or axis, upon which the brass joint turns, is then to be pressed firmly through the holes in the clamp, and the steel rod which has the slider upon it will stand perpendicular to the table by the pressure of the spring under it, similar to the joint of a clasp knife. This rod may now be moved from the right hand to the left, generating by its motion an imaginary semicircular plane, which is to be considered as the plane of the picture; by the union of this motion, and that of the slider upon the bar, the steel point may be brought to any given position in the plane of the picture.

The theory upon which this instrument is formed being understood, the practice will consist in placing the object to be drawn at a convenient distance from the supposed plane of the picture, and having fixed upon the height at which the eye of the spectator shall view the object; next determine the distance the picture shall be from the eye, or as it is frequently called, the point of sight. This being done, the eye of the artist must be applied to the hole in the eye-piece, and the steel point be brought to coincide with the extreme point of any line in the object to be drawn. Having performed this part of the operation with great exactness, the rod may be turned down by moving the brass piece upon its axis, using for this purpose the small handle, until the steel point comes in contact with the paper, when the fore-finger must be pressed upon it till the bent point enters it sufficiently to make a visible puncture, which is the perspective representation of one extreme point of the given line. The same operation is to be repeated to obtain the other, and the two points being joined by a line, it will be the perspective representation of the original line in the object to be drawn. When curved lines are the objects of delineation, any number of points may be obtained in them by the instrument, which being transmitted to the paper, and carefully drawn through with a steady hand and a fine pencil, the perspective representation of curved objects may be obtained with great ease. We have only to observe, the whole instrument can be packed up in a case 12 inches long, 3 inches wide, and 2½ inches deep.

SILK FROM SPIDERS.

THE useful properties possessed by the produce of the silkworm, and the value which it has acquired among civilised communities, have, at various times, led ingenious men to seek among the works of nature for other substances, which, presenting appearances analogous to that beautiful filament, might be made equally conducive to human convenience and adornment.

Some species of spiders are known to possess the power of not merely forming a web, but also of spinning, for the protection of their eggs, a bag somewhat similar in form and substance to the cocoon of the silkworm. At the commencement of the last century a method was discovered in France by Monsieur Bon, of procuring silk from the bags of the spider, and its use was attempted in the manufacture of several articles. The following particulars are gathered from a dissertation published at the time by M. Bon, and also from papers on the subject inserted in the volumes of the Royal Academy for the years 1710 and 1711.

Spiders are usually classed according to their difference of color, whether black, brown, yellow, &c., or sometimes by the number and arrangement of their eyes: of these organs some possess no fewer than ten, others eight, and others again six. M. Bon has, however, noticed only two kinds of silk spiders, and these he has distinguished from each other as having either long or short legs, the last variety producing the finest quality of raw silk. According to this ingenious observer, the silk formed by these insects is equally beautiful, strong, and glossy with that formed by the bombyx. The spider spins minute fibres from fine papillæ, or small nipples, placed in the hinder part of its body. These papillæ serve the office of so many wire-drawing irons, to form and to mould a viscous liquor, which after being drawn through them dries on exposure to the air, and forms the silk.

The celebrated naturalist M. Reaumur, who likewise bestowed considerable attention on these insects, discovered that each of their papillæ consists of a number of smaller ones, so minute as not to be discernible, and only made evident by the effects produced. If the body of the spider be pressed between the fingers, the liquor from which the threads are formed flows into the papillæ, by applying the finger against which, distinct threads may then be drawn out through the several perforations of each papilla. These threads are too fine to be counted with any accuracy, but it is evident that very many are sent forth from each of the larger papillæ. This fact tends to explain the power possessed by the spider of producing threads having different degrees of tenuity. By applying more or fewer of these papillæ against the place whence it begins its web, the spider joins into one thread the almost imperceptible individual filaments which it draws from its body; the size of this thread being dependent on the number of nipples employed, and regulated by that instinct which teaches the creature to make choice of the degree of tenuity most appropriate to the work wherein it is about to engage. M. Bon was able to distinguish fifteen or twenty fibres in a single thread, while Reaumur relates that he has often counted as many as seventy or eighty fibres through a microscope, and perceived that there were yet infinitely more that he could reckon; so that he believed himself to be far within the limit of truth in computing that the tip of each of the five papillæ furnished 1000 separate fibres: thus supposing that one slender filament of a spider's web is made up of 5000 fibres!

The threads produced by spiders are of two kinds. The first, which serves only to form the web which the insect spreads to entrap its prey, is very fragile; while the second, which is used to inclose the eggs of the female, is much stronger, thus affording to them shelter from cold, and protection from other insects which might otherwise destroy them. The threads are, in this operation, wound very loosely round the eggs, in a shape resembling that of the cocoon of the silkworm, after it has been prepared and loosened for the distaff. When first formed, the color of these spiders' bags is grey, but, by ex-

posure to the air, they soon acquire a blackish hue. Other spider bags might probably be found of other colors, and affording silk of better quality, but their scarcity would render any experiment with them difficult of accomplishment; for which reason M. Bon confined his attention to the bags of the common sort of the short-legged kind.

These always form their bags in some place sheltered from the wind and rain, such as the hollow trunks of trees, the corners of windows or vaults, or under the eaves of houses. A quantity of these bags was collected by M. Bon, from which a new kind of silk was made, said to be in no respect inferior to the silk of the bombyx. It took readily all kinds of dyes, and might have been wrought into any description of silken fabric. M. Bon had stockings and gloves made from it, some of which he presented to the Royal Academy of Paris, and others he transmitted to the Royal Society of London.

This silk was prepared in the following manner:—Twelve or thirteen ounces of the bags were beaten with the hand, or by a stick, until they were entirely freed from dust. They were next washed in warm water, which was continually changed until it no longer became clouded or discolored by the bags under process. After this they were steeped in a large quantity of water wherein soap, saltpetre, and gum-arabic had been dissolved. The whole was then set to boil over a gentle fire during three hours, after which the bags were rinsed in clear warm water to discharge the soap. They were finally set out to dry, during some days, previous to the operation of carding, which was then performed with cards differing from those usually employed with silk in being much finer. By these means silk of a peculiar ash color was obtained, which was spun without difficulty. M. Bon affirmed that the thread was both stronger and finer than common silk, and that therefore fabrics similar to those made with the latter material might be manufactured from this, there being no reason for doubting that it would stand any trials of the loom, after having undergone those of the stocking frame.

The only obstacle, therefore, which appeared to prevent the establishing of any considerable manufacture from these spider bags was the difficulty of obtaining them in sufficient abundance. M. Bon fancied that this objection could soon be overcome, and that the art of domesticating and rearing spiders, as practised with silkworms, was to be attained. Carried away by the enthusiasm of one who, having made a discovery, pursues it with ardor undismayed by difficulties, he met every objection by comparisons, which perhaps were not wholly and strictly founded on fact.* Contrasted with the spider, and to favour his arguments, the silkworm in his hands made a very despicable figure. He affirmed that the female spider produces 600 or 700 eggs; while of the 100, to which number he limited the silkworm, not more than one half were reared to produce balls.

That the spiders hatched spontaneously, without any care, in the months of August and September; that the old spiders dying soon after they have laid their eggs, the young ones live for ten or twelve months without food and continue in their bags without growing, until the hot weather, by putting their viscid juices in motion induces them to come forth, spin, and run about in search of food.

Mons. Bon flattered himself by this partial comparison, that if a method could be found of breeding young spiders in apartments, they would furnish a much greater quantity of bags than silkworms. Of about 700 or 800 young spiders which he kept, hardly one died in a year; whereas, according to this gentleman's estimate, of 100 silkworms not forty lived to form their cocoons. His spider establishment was managed in the following manner:—Having ordered all the short-legged spiders which could be collected by persons employed for the purpose, to be brought to him, he enclosed them in paper coffins and pots; these were covered with papers, which, as well as the coffins, were pricked over their surface with pin holes to admit air to the prisoners. The insects were duly fed with flies, and after some time it was found on inspection that the greater part of them had formed their bags. This advocate for the rearing of spiders contended that spiders' bags afforded much more silk in proportion to their weight than those of the silkworm; in proof of which he observed, that thirteen ounces yield nearly four ounces of pure silk, two ounces of which were sufficient to make a pair of stockings; whereas stockings made of common silk were said by him to weigh seven or eight ounces.

Some persons had imagined that the spider was venomous, and that this evil quality extended to the silk which it produced. Mons. Bon combated this prejudice by the assertion, that he had several times been bitten by spiders, when no injury had ensued; and that the silk, so far from being pernicious, had been found efficacious in stanching and healing wounds, its natural gluten acting as a kind of balsam.

The Royal Academy of Paris having considered the subject deserving of investigation, appointed M. Reaumur to inquire into the merits of this new silken material. In the course of his examination this naturalist discovered many serious objections, the narration of which will show the inexpediency of M. Bon's projected establishments. Mons. Reaumur urged that the natural fierceness of spiders rendered them totally unfit to be bred and reared together. On distributing 4000 or 5000 into cells, in companies of from 50 to 100 or 200, it was found that the larger spiders quickly killed and ate the smaller, so that in a short time the cells were depopulated, scarcely more than one or two being found in each cell. To this propensity for mutual destruction, M. Reaumur ascribes the scarcity of spiders in comparison with the vast number of eggs which they produce. But if even it were possible to change their warlike nature, and bring these insects together in peaceful community, there are other objections to deter from the attempt.

M. Reaumur affirmed, that the silk of the spider is inferior to that of the silkworm, both in lustre and strength, and that it produced proportionally less material available to purposes of manufacture. All this was satisfactorily proved; although in his reasoning some little exaggeration was likewise employed in opposition to the coloring of M. Bon. The thread of the spider's web was found capable of sustaining a weight of only two grains without breaking; and the filament of the bag, although much stronger than this, could only sustain thirty-six grains, while that of the silkworm will support two drachms or two drachms and a half. "Thus four or five threads of the spider," said M. Reaumur, "must be brought together to equal one thread of the silkworm." Now it is impossible that these should be applied so justly over another as not to leave little vacant spaces between them, whence the light will not be reflected; and, consequently, a thread thus compounded cannot equal in lustre a solid thread. It is another great disadvantage of the spiders' silk,

that it cannot be wound off the ball like that of the silkworm,* but must necessarily be carded; and therefore its evenness, which contributes so materially to its lustre, is destroyed. That this effect was in reality produced, is further confirmed by the testimony of M. le Hire, who, when the stockings of M. Bon were presented to the Royal Academy, immediately noticed their want of lustre.

Another objection urged by M. Reaumur against the rearing of spiders was the small quantity as well as deficient quality of the silk they produce. In making a comparison in this respect between them and the silk-worm, extreme cases were taken, that the conclusion might be rendered more striking. "The largest cocoons," said this naturalist, "weigh four, and the smaller, three grains each; spiders' bags do not weigh above one grain each, and after being cleared of their dust, have lost two-thirds of this weight." He calculated, therefore, that the work of twelve spiders only equals that of one silkworm; and that a pound of silk would require for its production 27,648 insects. But as these bags are wholly the work of the females, who spin them as a deposit for their eggs, it follows that 55,296 spiders must be reared to yield one pound of silk: yet even this will be obtained from only the best spiders, those large ones ordinarily seen in gardens, &c., yielding not more than a twelfth part the silk of the others. The work of 280 of these would, therefore, not yield more silk than the produce of one industrious silkworm, and 663,552 of them would furnish only one pound of silk! This latter calculation is however decidedly erroneous in its several steps, and appears rather to be a flight of the imagination than the result of sober induction. The advantages of the culture of silk from the silkworm, when compared with its production from spiders, are so prodigious, and at the same time so evident, that to prove the futility of M. Bon's scheme needed not the aid of exaggeration.

WINDS

WINDS are phenomena in a great measure dependent on the law, that lighter fluids rise in heavier. As oil let loose under water is pressed up to the surface and swims, so air near the surface of the earth, when heated by the sun, rises to the top of the atmosphere, and spreads there, forced up by the heavier air around. This heavier air rushing inwards, constitutes the wind felt at the surface of the earth. The cross currents in the atmosphere, arising as now described, are often rendered evident by the motion of clouds or balloons.

If our globe were at rest, and the sun were always beaming over the same part, the earth and air directly under the sun would become exceedingly heated, and the air would there be constantly rising like oil in water, or like the smoke from a great fire; while currents or winds below would be pouring towards the central spot, from all directions. But the earth is constantly turning round under the sun, so that the whole middle region or equatorial belt may be called the sun's place: and therefore according to the principle just laid down, there should be over it a constant rising of air, and constant currents from the two sides of it, or the north and south, to supply the ascent. Now this phenomenon is really going on, and has been going on ever since the beginning of the world, producing the steady winds of the northern and southern hemispheres, called trade winds, on which in most places within 30 degrees of the equator, mariners reckon almost as confidently as on the rising and setting of the sun himself.

The trade winds, however, although thus moving from the poles to the equator, do not appear on the earth to be directly north and south, for the eastward whirling, or diurnal rotation of the earth, causes a wind from the north to appear as if coming from the north-east, and a wind from the south as if coming from the south-east. This fact is illustrated by the case of a man on a galloping horse, to whom a calm appears to be a strong wind in his face; and if he be riding eastward, while the wind is directly north or south, such wind will appear to him to come from the north-east, or south-east:—or again, is illustrated by the case of a small globe made to turn upon a perpendicular axis, while a ball or some water is allowed to run from the top of it downwards;—the ball or water will not immediately acquire the whirling motion of the globe, but will fall almost directly downwards, in a track which, if marked upon the globe, will appear not as a direct line from the axis to the equator, that is, from north to south, but as a line falling obliquely. Thus then, the whirling of the earth is the cause of the oblique and westward direction of the trade winds, and not, as has often been said, the sun drawing them after him.

The reason why the trade winds, at their external confines, which are about 30° from the sun's place, appear almost directly *east*, and become more nearly *north* and *south* as they approach the central line, is, that at the confine they are like fluid coming from the axis of a turning wheel, and which has approached the circumference, but has not yet acquired the velocity of the circumference; while, nearer the line, they are like the fluid after it has for a considerable time been turning on the circumference, and has acquired the rotatory motion there, consequently appearing at rest as regards that motion, but still leaving sensible any motion in a cross direction.

While, in the lower regions of the atmosphere, air is thus constantly flowing towards the equator, and forming the steady trade winds between the tropics, in the upper regions there must of course be a counter-current distributing the heated air again over the globe, accordingly, since reasoning led men to expect this, many striking proofs have been detected. At the summit of the Peak of Teneriffe, observations now shew that there is always a strong wind blowing in a direction contrary to that of the trade wind on the face of the ocean below. Again, the trade winds among the West-India Islands are constant, yet volcanic dust thrown aloft from the island of St. Vincent, in the year 1812, was found, to the astonishment of the inhabitants of Barbadoes, hovering over them in thick clouds, and falling, after coming more than 100 miles directly against the strong trade winds, which ships must take a circuitous course to avoid. Persons sailing from the Cape of Good Hope to St. Helena, have often to remark that the sun is hidden for days together, by a stratum of dense clouds passing southward high in the atmosphere; which clouds consist of the moisture raised near the equator with the heated air, and becoming condensed again as it approaches the colder regions of the south.

Beyond the tropics, where the heating influence of the sun is less, the winds occasionally obey other causes than those we have now been considering,

which causes have not yet been fully investigated The winds of temperate climates are in consequence much less regular, and are called *variable;* but still, as a general rule, whenever air is moving towards the equator, from the north or south poles where it was at rest, it must have the appearance of an east wind, or a wind moving in the contrary direction to the earth itself, until it has gradually acquired the whirling motion of that part of the surface of the earth on which it is found; and again, when air is moving from the equator, where it had at last acquired nearly the same motion as that part of the earth, on reaching parts nearer the poles, and which have less eastward motion, it continues to run faster than they, and becomes a westerly wind. In many situations beyond the tropics the westerly winds, which are merely the upper equatorial currents of air falling down, are almost as regular as the easterly winds within the tropics, and might also be called trade winds:—witness the usual shortness of the voyages from New York to Liverpool, and the length of those made in the contrary direction. North of the equator, then, on earth, true north winds appear to be north-east, and true south winds appear to be south-west,—which are the two winds that blow in England for three hundred days of every year. In southern climates the converse is true.

While the sun is beaming directly over a tropical island, he warms very much the surface of the soil, and therefore also the air over it; but the rays which fall upon the ocean around penetrate deep into the mass, and produce little increase of superficial temperature. As a consequence of this, there is a rapid ascent of hot air over the island during the day, and a cooler wind blowing towards its centre from all directions. This wind constitutes the refreshing *sea-breeze* of tropical islands and coasts. A person must have been among these, to conceive the delight which the sea-breeze brings after the sultry stagnation which precedes it. The welcome ripple shorewards is first perceived on the surface of the lately smooth or glassy sea; and soon the whole face of the sea is white with little curling waves, among which the graceful canoe, lately asleep on the water, now shoots swiftly along.

During the night a phenomenon of opposite nature takes place. The surface of the earth, then no longer receiving the sun's rays, is soon cooled by radiation, while the sea which absorbed heat during the day, not on the surface only, but through its mass, continues to give out heat all night. The consequence is, that the air over the sea, sinks down, and spreads out on all sides, producing the *land-breeze* of tropical climates. This wind is often charged with unhealthy exhalations from the marshes and forests, while the sea-breeze is all purity and freshness. Many islands and coasts would be absolutely uninhabitable but for the sea-breeze.

The peculiar distribution of land in the Asiatic part of the globe, produces the curious effect there of a sea-breeze of six months, and a land-breeze of six months. The great continent of Asia lies chiefly north of the line, and during its summer, the air over it is so much heated, that there is a constant steady influx from the south—appearing south-west, for the reason given in the preceding page; and during its winter months, while the sun is over the southern ocean, there is a constant land-breeze from the north—appearing, for a like reason, north-east. These winds are called *monsoons;* and if their utility to commerce were to be a reason or a name, they also deserve the name of trade winds. In early periods of navigation, they served to the mariner the purpose of compass, as well as, of moving power; and one voyage outward, and another homeward with the changing monsoons, filled up his year.—On the western shores of Africa and America also, the trade winds are interfered with by the heating of the land; but much less so than in Asia, and always in accordance with the laws now explained.

The frightful tornadoes, or whirlwinds, which occasionally devastate certain tropical regions, making victims of every ship or bark caught on the waters, and the short gusts or squalls met with every where, are owing to some sudden chemical changes in the atmosphere, not yet fully understood.

COMPOSITION OF ARTIFICIAL GEMS.

A very considerable portion of every treatise on glass-making, which was in existence a century ago, and which comprises nearly the whole of what has ever been published on the subject, was devoted to the art of composing factitious gems. A great deal of mystery would seem to have been affected upon this subject on the part of the manufacturers, each one of whom was, or pretended to be, possessed of some secret *recipe,* which he thought superior to all others for the composition of these ornaments.

A corresponding anxiety to acquire a knowledge of these mysteries being evinced on the part of the public, the authors above alluded to, so far acquiesced in this feeling as to load their writings with one receipt after another, in almost endless succession, and in following which the artist was assured, that he might successfully rival nature in the production of these much-admired objects.

The greater part of the compositions thus recommended, if indeed they were ever used, have long since passed into neglect; and it will not be necessary, in the present day, to insert more than a few directions on the subject, which are given upon the authority of M. Fontanieu, as being well qualified, with the addition of various coloring matters, for counterfeiting precious stones.

No. 1, is composed of 20 parts of litharge, 12 of silex, 4 of nitre, 4 of borax, and 2 parts of white arsenic. These ingredients should be fritted together in a crucible, and afterwards melted, in which state the whole must be poured suddenly into cold water. Any portion of lead which may have been revived in the metallic state will then be apparent and must be separated. The glass may then be remelted for use.

No. 2. For this composition, mix together 20 parts of ceruse, 8 of calcined silex in powder, 4 of carbonate of potash, and 2 of borax. When these are perfectly melted, the whole should be poured into water, and then re-melted in a clean crucible, in the same manner as No. 1.

No. 3, consists of 16 parts of minium, 8 of rock crystal in powder, 4 of nitre, and 4 of carbonate of potash. These ingredients must be melted and remelted in the manner already described as necessary with the preceding mixtures.

No. 4, differs essentially from the three foregoing combinations in being without any portion of lead. It is made with 24 parts of borax, 8 parts of rock crystal, and 8 of carbonate of potash. The rock crystal, previous to its use for this purpose, must

be reduced to a state of great purity, by fusing it with an excess of alkali, and then precipitating it by an excess of acid, in the form of an impalpable powder.

No. 5. The processes necessary for the production of this species of glass are much more complex than the preceding. In the first place, 3 parts of alkali are to be fritted with 1 part of rock crystal, which mixture must then be dissolved in water and saturated with dilute nitric acid. The silex which is precipitated by this means must then be edulcorated and dried, when it will appear in the form of a very fine impalpable powder. Two parts of this must be melted in a crucible with 3 parts by weight of the best ceruse, and the glass which results must be poured into water. Break this down and re-melt it with one-twelfth of its weight of borax, and pour it again into water. If this last product is once more melted with one-twelfth of its weight of nitre, the result will be a very fine hard glass, having an extremely beautiful lustre.

The length of time required for fusing hard glasses or *pastes* is at the least twenty-four hours. The process herein directed, of pouring the melted glass into water, and then re-melting, is found to be of considerable use in thoroughly and intimately mixing the ingredients together.

Of the foregoing compositions, No. 1, will be found extremely fusible, on account of its considerable proportion of fluxing materials. It calls for the employment of the very best description of crucibles, in order to withstand, for the requisite time, the corroding effects of the mixture. If any kind of glass into the composition of which lead has not entered, is applied to and melted on the interior surface of the crucible, so as to line it with a perfect glaze previous to use, the evil just mentioned will be materially remedied.

In order to make a perfect glass, which at the same time shall be sufficiently workable, 2 parts of silex require from 3 to 4 parts, by weight, of oxide of lead; but a somewhat smaller quantity of the latter may be used, if the deficiency is made up by the addition of some other fluxing material: the glass in this case will prove both hard and brilliant; and, when properly set, will exhibit a much nearer imitation of the diamond than most other vitreous compositions.

It was formerly imagined by artists who wrought these artificial gems, that if the glass employed by them had for its basis rock crystal, rather than sand, flint, or any other mineral of the like character, the result was a much harder glass than ordinary. This idea, is, however, wholly without foundation; for when the crystal has once been fused through the admixture of any kind of flux, the hardness of the mineral will be irrecoverably lost, as this quality depends altogether upon its natural aggregation, which, in such case, is necessarily destroyed.

Rock crystal is, perhaps, somewhat purer than most other siliceous substances, some of which contain minute traces of iron, and which may possibly impair the beauty of some colors which are imparted to glass. The same means as are used to render flint friable, are employed for that purpose with rock crystal: this should on no account be ground in metallic vessels.

Some artists have succeeded, to a certain extent, in producing a very fine, hard, brilliant, and colorless glass paste, in imitation of the diamond, and have even given to this a very considerable play of light, or, as it is technically termed, *water;* but it has not been found practicable to compound any vitreous substance which could for a moment deceive the eye of any person accustomed to witness the superior brilliancy of real gems. The best of these mock diamonds require, indeed, the aid of artifice in the mode of their setting, to render them in any great degree ornamental. M. Fontanieu recommends his glass, No. 1, described above, as being better qualified than any other for making artificial diamonds. To bring this glass to such a degree of brilliancy and clearness as will prove at all satisfactory, it must be retained in a state of perfect fusion for a considerable space of time.

Loysel recommends, for the same purpose, the employment of a different composition, the result of which will be a glass, having the same specific gravity as the white oriental diamond, and for this reason better imitating that resplendent substance in its refractive and dispersive powers. His recipe is as follows:—

White sand purified by being washed first in muriatic acid, and afterwards in pure water, until all traces of the acid are removed ..	100 parts
Red oxide of lead (minium)	150
Calcined potash	30 to 35
Calcined borax	10
Oxide of arsenic................	1

This composition is easily fusible at a moderate heat; but like that proposed by Fontanieu, requires to be kept in a melted state for two or three days, to perfect the refining, and to cause the dissipation of the superabundant alkali

The same author has furnished the following receipts for the formation of pastes, qualified, upon the addition of appropriate coloring materials, for the imitation of various gems. The remarks already made as to the length of time required for the due preparation of the diamond paste equally apply to these compositions:—

White sand, purified in the manner pointed out in the preceding receipt......................	100 parts.
Red oxide of lead	200
Calcined potash, and nitre, of each	20 to 25

The specific gravity of this glass, water being 1 will be 3·9 to 4.

White sand, prepared in the manner before mentioned.............	100 parts.
Red oxide of lead	300
Calcined potash	5 to 10
Calcined borax	200 to 300

The specific gravity of this compound will vary from 3·3 to 4.

White sand, prepared as above	100 parts.
Red oxide of lead	250
Calcined potash	15 to 20
Calcined borax	25 to 30

This will have a greater specific gravity varying from 4 to 4·5.

In making this selection between one or other of these pastes, the artist should be guided by their various specific gravities, choosing preferably that glass which is nearest in this respect to the particular gem which he is desirous of imitating; and this, not with the view of providing himself with an additional means of deception, but because, the refractive and dispersive powers of different transparent bodies being determined by their comparative weights, the resemblance will, by such a selection, be rendered more perfect to the eye. To one simple test that of their hardness. recourse can be had, so

easily, that every one may, with very little previous instruction, ascertain for himself the genuineness of any gem that is offered to his notice, without any apprehension of being deceived.

Neri, Kunckel, and Fontanieu have left in their writings many *recipes* for the preparation of artificial gems through the employment of different coloring materials. The directions, as given in the works of these authors, differ so importantly the one from the other as regards the proportions best fitted for the composition of the same article, that we are forced to believe either that some great errors have been committed on the part of their subsequent editors, or that the writers themselves were wanting in the kind and degree of knowledge to which they pretended, and which were required to fit them for the task they undertook.

A few of these recipes, and such as appear most free from this objection, may be here given.

The basis of each of these compositions is most frequently either one of the colorless glasses or pastes described above, or some other very similar vitreous compound; but it sometimes happens that the constituent materials of the glass, and the proportions wherein they are to be brought together, are indicated as well as the coloring substances.

The following is recommended by Neri, as furnishing a very excellent imitation of the garnet:—Rock crystal 2 ounces, minium 6 ounces, manganese 16 grains, zaffre 2 grains. This must be a very inconvenient composition, both on account of the exceeding softness of the glass, and the destructive effect it would have upon the crucible during the time of its preparation. We learn from the analysis of Berzelius, that the coloring matter of the "precious garnet," that being the variety which it is wished thus to imitate, consists of the black oxide of iron and oxide of manganese. A more modern recipe than the foregoing for the successful imitation of this gem, consists of purest white glass 2 ounces, glass of antimony 1 ounce, Cassius's precipitate 1 grain, oxide of manganese 1 grain; which composition is free from the objections to which that of Neri is so justly exposed.

The directions of Fontanieu for imitating the color of the amethyst are, that to 24 ounces of the glass composed according to instructions given above, under the number 5, are to be added half an ounce of the oxide of manganese, 4 grains of the purple precipitate of gold, and 1½ ounce of nitre, but it is impossible to believe that the recipe of Fontanieu has been correctly given. The quantity of coloring matter here indicated would be better proportioned to 24 pounds of glass, than to the same number of ounces as directed.

Many, and greatly varying instructions have been given for imitating the emerald. Fontanieu recommends 160 parts of any glass basis which contains a large proportion of lead, 4 parts of oxide of copper prepared by simple calcination, and one-eighteenth of a part of any oxide of iron; which last ingredient is added for the purpose of giving something like a richness of tint, and for correcting the coldness of hue that would result from the employment of the oxide of copper alone. The presence of lead in the glass would also conduce to the same end.

Another rule given from the same authority directs the use of 576 parts of glass, similarly constituted to that pointed out in the last receipt, 6 parts of the same oxide of copper, and only 1-144th of part of oxide of iron; thus differing from the former compound, only as to the proportions wherein the coloring ingredients are employed.

A third receipt for the attainment of the same object is very different from the two preceding. It recommends the employment of 200 parts of fine sand, 400 parts of minium, 8 of calcined verdigris, and as much as 1 part of oxide of iron. A fourth method for the composition of glass of an emerald green is, to mix, in due proportions, some blue glass colored by means of oxide of cobalt, with yellow glass prepared with oxide of antimony. A great many other prescriptions are offered for the imitations of emeralds, but these vary more in the relative proportions of their ingredients than in the principle of their composition; and it cannot, therefore, be necessary to insert them here.

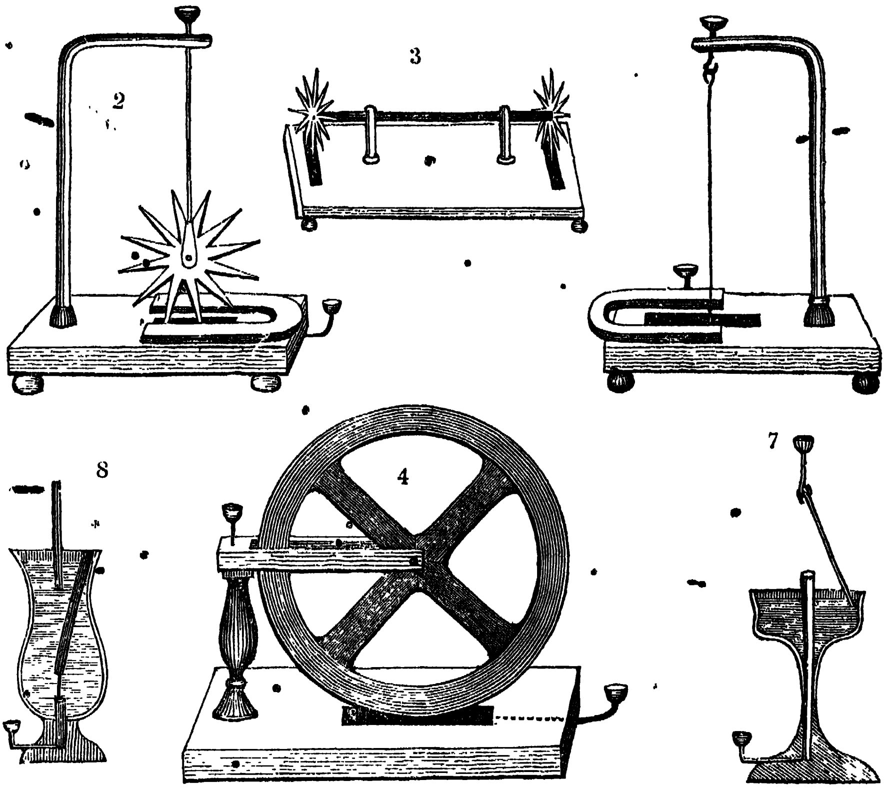
The imitation of sapphires is always effected through the coloring agency of the oxides of cobalt and manganese. There is, however, a material difference as regards the basis of the glass in the various directions which are found for the purpose; one recommending that this shall be composed without lead, and another directing that this mineral shall enter largely into the composition of the paste. To 100 parts of glass of the first kind it is directed that 1 part of zaffre, and one-sixteenth of a part of oxide of manganese shall be added. Where the second description of paste is recommended as the basis, the artist is directed to prepare this by adding to 240 parts of glass frit made with only soda and silica, 192 parts of minium, 2 of zaffre, and ⅓d of a part of manganese. This compound must be fused together, poured into water, and then remelted as directed by Fontanieu, for the formation of the pastes before described.

The oxide of cobalt is, in the present day, a necessary ingredient in every imitation of the sapphire, so that it is never attempted to act without it.

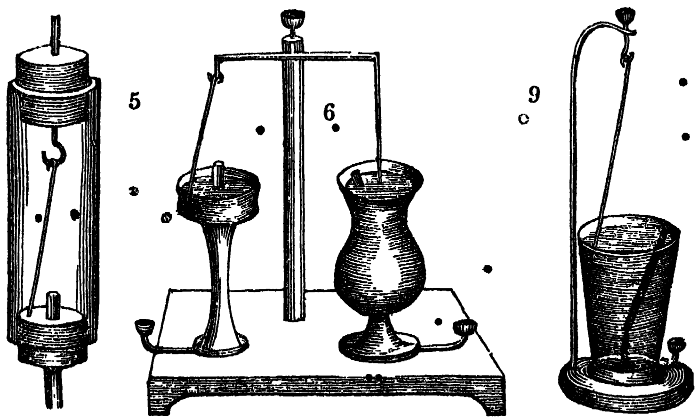
MISCELLANIES

Method of Zincing Copper and Brass.—M. Boettiger has succeeded in covering plates and wires of copper, brass, pins, &c., with a brilliant coating of zinc. His method is as follows:—Granulated zinc is prepared by pouring the fused metal into a mortar of heated iron, and stirring it rapidly with the pestle until it is solidified. The metal thus granulated is placed in a porcelain capsule, or in some other non-metallic vessel. A saturated solution of sal-ammoniac is poured over it; the mixture is boiled; the objects to be rendered white are now placed in it, previously dipped in dilute hydrochloric acid; in a few minutes they are covered with a brilliant coating of zinc, which it is very difficult to remove by friction. The galvanic action is thus explained:—The double chloride of zinc and ammonium formed is decomposed by the zinc and the plate of copper; the chlorine disengaged from the sal-ammoniac goes to the zinc; the ammonium is disengaged in the form of gas, and the undecomposed sal-ammoniac combines with the chloride of zinc to form the double chloride, a very soluble and easily decomposed salt. If then an excess of zinc exists in the solution in contact with the electro-negative copper, the salt is decomposed into its elements, and the reduced zinc is deposited on the negative copper.

Fig. 1.



ELECTRO-MAGNETIC APPARATUS.

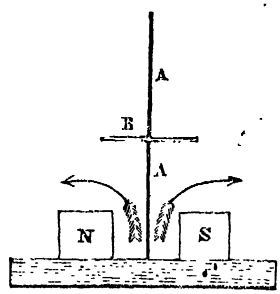


ELECTRO-MAGNETISM.

(Resumed from page 339.)

THE influence which the earth's magnetism has upon electrical currents, and upon wires bearing electrical currents, having been explained, the next part of the science is to show, that when subjected to the proximity of artificial magnets, the wires which are electrified become influenced in a similar manner, but with greater intensity; and this, because, however enormous may be the power of terrestrial magnetism, taken in the aggregate, yet, as the magnetic fluid acts with a force which diminishes in proportion to the distance of it, in a geometrical ratio; the power of a small magnet, placed close to an electrical current, may be equal, or even superior to the magnetic power of the whole earth, if acting at the distance of hundreds of miles. Thus also we are enabled to show the mutual influence of these powers in every manner that experiment can suggest, in opposition even to the earth's magnetism. This being premised, we will refer to the paper, (page 171,) in explanation of the power of magnetism in putting in motion the wires conveying an electrical stream; and applying the laws there laid down, we shall easily understand the reason of action of the apparatus about to be described, particularly the former of them. Fig. 1, represents Marsh's vibratory wire. It consists of a brass wire, suspended from a hook above, and dipping into a little trough of mercury below, the hook above and trough below being furnished with cups containing mercury, for the sake of metallic communication. If a horse-shoe magnet be placed on the foot-board of the apparatus, with its poles one on each side of the suspended wire, and a current of the electric fluid be made to pass down the wire, it will immediately move, and swing itself out of the mercury trough. This will, of course, break the current, and the wire will fall back again; when, in falling back, it a second time touches the mercury, the connection of the current will be once more complete, and the wire be again jerked out, so that, by this continued action, the wire will assume a quick vibratory motion. To render the cause of this plainer than we were before enabled to do, we must first assume, that a magnet influences an electrified wire, in two ways, one to make it rotate around itself, and the other to throw it off from a particular part or pole, or in other words, it exerts a tangential or centrifugal power over the electrical fluid, at the same time inducing the wires which serve as conductors to that electrical fluid, to be acted upon by polarity and attraction. This indeed has been already partly proved, and the present series of experiments will, it is hoped, render it more evident—as to the apparatus just described, we may explain the motion of the wire easily. Suppose the following cut to show an end view of the apparatus, N and S being the north and south poles of the magnet, and A A the wire which is suspended.

That the wire has a tendency to be thrown outwards from between the poles of the magnet, or else inwards towards the bend of the magnet, according to which cup is connected with the anode or positive pole of the battery, is easily seen by the experiment, and it would seem to be impelled by no other force; at any rate, no tangential force is apparent. If then, this force exists, what becomes of it in the present case. This natural question is easily answered. The north pole N, would, if the suspended wire were free to move sideways, draw it in the direction of the arrow around N. At the same time, the south pole would draw it in the



direction indicated by the other arrow; and, as these forces are always equal, they neutralize each other, and the suspended needle can obey neither, but is left to pursue its vibratory motion unmolested and uninfluenced by any other power than that which visibly affects it.

If we alter the last apparatus, so that it shall consist of a series of wires arranged like the spokes of a wheel, or, indeed, form a wheel of thin brass, as is represented in Fig. 2. it is evident, that when one wire or spoke is thrown up, it will not be necessary for it to return, in order that contact may be renewed, because the second spoke of the wheel will, as soon as the first is driven away, be brought down to the surface of the mercury, and complete the second current. This being thrown off, in like manner a third will succeed, and the spurred wheel be continued in a rapid rotatory motion as long as it is made the bearer of the electrical current. Two wheels may in like manner be employed, as seen in Fig. 3, both turning on the same spindle, they not being fixed to it.*

It is next incumbent on us to prove, that magnetic and electric currents exert a rotatory influence on each other, arising from their tangential force. In the last case, though rotation was produced, it was rather owing to a succession of repulsions upon separate and distinct wires, than to a continued action upon any one of them in particular. In the following experiments, however, it will be seen, that, under other circumstances, the force of the fluids upon each other, are uniform and long continued. We have stated above, that the wire, always supposing it to be the conductor of an electric current, revolves around the north pole of a magnet, in one direction, and around the south pole in a contrary direction. The apparatus, Fig. 5, will prove it. It consists of a glass tube, with a cork at each end; the pole of a magnet is made to pass through the lower cork, and a wire through the upper cork. The tube itself contains a little mercury, sufficient for the suspended wire to dip in. Upon connecting the poles of the galvanic battery with the upper wire and the magnet, the suspended wire will rapidly rotate around the pole in the centre: if the magnet be drawn out, and the other pole substituted, the wire will also rotate, but in a contrary direction.

* In this cut, the mercury cups, connected one with each trough of mercury and the two magnets requisite, one to each wheel, are purposely omitted, that the rest of the apparatus may be more easily seen; the magnet is also omitted in Fig. 4, for the same reason. A continuous wheel may also be used for the same purpose (Fig. 4.) and will exhibit the same rapid rotatory motion, as was proved by Mr. Sturgeon.

One half of Fig. 6 will show the same kind of rotation; the wire being suspended from a hook at the top of the cross arm, and mercury being poured into the cup. The other part of this apparatus reverses the above experiment; it is a deeper cup, filled with mercury, having a magnet capable of moving within it, and in which the wire which conveys the current is fixed. This is important, inasmuch as it shows, that here, as well as in all other sciences, action and reaction are equal; if the magnet affects the electrical conductor, so, in an equal degree. does the electrical conductor affect the magnet. The Figs. 7 and 8 show the internal structure of both the above articles of apparatus. Fig. 9 shows how both effects may be produced simultaneously, the wire and magnet being both loose, revolve around each other.

(To be continued.)

SKINNING AND STUFFING REPTILES AND FISH.

REPTILES.

Tortoises and Turtles.—The bodies of this tribe are enveloped in two plates, or shields, the upper one is formed of the ribs, and the under one of the sternum, or breast bone.

The first operation is to separate the back and breast shells with a strong short knife, or chisel. If the force of the hand is inadequate, a mallet may be used, taking care not to strike so hard as to crack the shell.

These two bony plates being covered by the skin, or by scales, the scapula, and all the muscles of the arm and neck, in place of being attached to the ribs and spine, are placed below, from which cause the tortoise has been termed a retroverted animal. The vertebral extremity of the scapula is articulated with the shield, and the opposite extremity of the clavicle with the breast-plate in such a manner, that the shoulders form a ring for the passage of the trachea and œsophagus.

After the turtle is opened, all the flesh which adheres to the breast-plate, and also to the upper shell, is removed, while attention is paid to the parts as above described. The head, fore-feet, and tail are skinned as in quadrupeds; but none of these must be removed from the upper shell, but left attached.

All the fleshy parts being removed, the shells are washed out with a sponge, and carefully dried. They are then slightly rubbed with the arsenical soap. (See No. I.)

Wires are now passed through the middle of the legs, after the skin has been rubbed with the preservative. The skull is returned to its place, and the whole of the head, neck, and legs stuffed with chopped flax, or tow. The parts of the skin, which have been cut, are then sewed together. The back and breast plates are united by four small holes, being bored at their edges, and united by strings or small wires. The junction of the bones may then be attached with the cement, colored so as to correspond with the shell.

If the upper shell is dirty, it may be cleaned with a slight solution of nitric-acid and water; afterwards clean washed, oiled, and then rubbed hard with a woollen rag, to give it a polish.

Crocodiles and Lizards in general.—All this tribe are skinned in the same manner as quadrupeds Care is, however, required in skinning the tails of the smaller species, as they are very liable to break. The skins being of a dry nature, require but little of the preservative. After they are thoroughly dried they will keep a very long time without decay.

Stuff them as directed for quadrupeds. (See page 216.) They admit of but little variety of attitude. The small species are exceedingly apt to change color in drying, which must be imitated with the colored varnishes, and afterwards dimmed with sand paper. To keep them in their natural colors, they should be preserved in spirits.

The skins of such as are glossy should be varnished after they are perfectly dry.

Skinning in general.—In skinning serpents there is some nicety required, to cut them so as not to disfigure the scales; the opening should be made in the side, commencing at the termination of the scales; and they should on no account be divided, as upon their number the species is mostly determined.

It is a very frequent practice to send home serpents without the head, which renders them quite unfit for any scientific purpose. This proceeds from the fear of receiving poison from the fangs. But there is not the slightest danger of being affected, as these can easily be cut out by means of pincers. The head should be cleaned and the brain removed, the skull anointed, and then returned into the skin.

When the skin is removed, it may be rolled up and packed in small space. The simplest way to preserve small species is to put them in spirits, which must not be too strong, as it will destroy the colors.

Mr. Burchell, in his four years' journey through Africa, glued the skins of the smaller serpents perfectly flat on paper, which preserved the size of the animal, and the skin retained all the beauty of life.

The skin, if not recent, must be first softened by wrapping it in a damp cloth. A piece of wire is taken the length of the animal, which must be wrapped round with tow till it is of a proper thickness, and above the whole, a spiral band of silver should be carefully wrapped. It is then placed inside of the skin, and sewed up. The eyes are placed in, as directed for quadrupeds and birds. When dry, give the serpent a coat of varnish, and then twist it into any attitude wished. A favourite and striking one is to have it wound round some animal, and in the act of killing it.

Frogs and Toads.—The mouth is opened, and the first vertebra of the neck is cut. The whole inside of the mouth is cut out with scissors. The two jaws are next raised up, and the skin is pushed back with the fingers of the right hand; while the body is drawn back in a contrary direction with the other hand, and the whole body is then drawn out at the mouth. The legs are then returned to their proper place.

The simplest method of stuffing these animals is with sand. A small funnel is placed in the mouth, and well-dried sand poured in. When full, a small piece of cotton is put into the throat, with some of the cement, to keep the sand from escaping on moving the animal.

The frog is then placed on a board, and in an attitude. When quite dry, give it a coat of varnish. When this has perfectly dried, very small perforations are made under the belly with the point of a needle, and the sand allowed to escape, leaving the body of its natural form.

These animals are liable to change of color from

drying, and should, therefore, be painted with the varnish to their natural hues. There is less difficulty with toads in this respect, as they are usually of a brown color, and not liable to much change. They may be perfectly preserved in spirits.

FISHES.

This class of animals, in their native element, have many attractions: some for the singularity of their forms, and others for the resplendent and beautifully contrasted arrangement of their colors; while many exhibit iridescent tints, which vie with the splendor of the peacock, or humming-bird, reflecting vivid, golden, metallic hues of all shades. But these are too evanescent for the powers of the taxidermist; for no sooner are they removed from the water, than their transient and fading beauty vanishes for ever.

The best method of securing the scales and colors of fish is, as soon as they are caught, to apply cambric or tissue paper to them, which will soon dry and adhere firmly; the body may be then taken out and the skin dried. When the skin is to be stuffed, roll it in a moist cloth, which will not only render it pliable, but also soften the tissue paper, so as it can be removed, when the colors will be found to be much brighter than by any other method with which we are yet acquainted. Lampreys, eels, and other fish of similar form, may be skinned in the same manner as frogs and toads, by drawing the body through the mouth.

Skinning Fish in general.—The fish should be procured as fresh as possible, more particularly if it is one of those on which the scales are loosely attached. Lay it on one side and cut out the gills with a pair of scissors, then introduce a little tow or a piece of sponge into the place to prevent the blood from flowing during the process of skinning; carefully wipe the sides of the fish with a damp sponge; let the fins be raised and gently extended, and two pieces of paper, something the shape of each, be placed under them, only extending a little beyond them. Coat the paper with a weak solution of gum arabic, and put a piece of similar size on the top of the fin: by pressing these gently they will adhere and dry in a few minutes: these will keep the fins extended, and preserve them during the operation of stuffing. When these are dry, take a piece of tissue paper or thin silk, and press it gently on one side of the fish. The natural glutinous matter which covers the scales will be sufficient to make it adhere firmly, it will soon dry and form a strong protection to the scales during the skinning; without this precaution the skin could not be removed from mullet, sea beaver, &c., without the scales being much disfigured, and losing many of them. Indeed, in such fishes, it is not amiss to put an additional coating of paper with gum-water. This will not only secure the scales, but will also assist in keeping the proper form of the flesh, by preventing distention.

When these papers are thoroughly dry, turn the fish on a soft cloth, with the uncovered side upwards, and open it with sharp scissors from the bottom of the tail-fin to nearly the point of the snout, keeping as correctly on the lateral line as possible, which can be seen in most fishes. The cheek should be afterwards cut open, so that the flesh may be removed from it; cut also the flesh from the opposite cheek, and supply its place by cotton. The skin must now be detached from the flesh, which will require some care at first. It must be commenced at the head, and separating it downwards with the assistance of the knife, and the fin-bones must be cut through with scissors. The spine must now be cut through close to the head, and also at the tail, and the body removed.

All the animal matter having been completely removed from the skin, the inside must be wiped dry, and the preservative applied in the same manner as directed for birds and quadrupeds. Great care is necessary to prevent it from being too much distended.

In sharks and large fishes, an incision is made below the head, and extended to the fin of the tail; the skin is then separated on each side with a scalpel, cutting back as far as possible, so that the vertebra may be cut close to the head. The tail is then skinned. The head is pushed inwards, and the skin passed over it above, and all the cartilage cut carefully away. Care must be taken not to enlarge the branchial openings too much, which would render it necessary to sew them up again, and it is not easy to hide a seam in a fish's skin.

Diadon, tetradon, and balistes, and their congeners, are opened by the belly. The ostracion is enveloped in a skin, which consists of a single piece, the tail of which only is free and flexible. The opening in the belly must not be large; the tail must be opened, the flesh cut away, and stuffed with cotton.

Stuffing.—The skins being properly anointed, are filled with tow or cotton, This must be so managed that there will be no prominences on the outside of the skin, which, in fishes, for the most part, is smooth and even. When properly filled, they must be sewed up, and set aside to dry in the air, but not exposed to the rays of the sun. In a few days, the papers with which the fins were extended, are taken off, by damping them with a sponge. The glass eyes are now introduced, after filling the orbits with cotton and a little cement to secure them in their places. The skins may then be varnished, and laid aside to dry.

In stuffing sharks, it is necessary to use a stick for a centre support. This must also enter the head, through the opening of the throat. If it is intended that the specimen shall be suspended from the ceiling, wire-hooks must be fastened into the wood. From these must be placed upright wires, so that they penetrate the skin, and pass through the back. Let the whole internal surface of the skin be well rubbed with the preservative. The body is then stuffed to its full size, and afterwards sewed up. The stuffing of the head must be completed through the orbits of the eyes, and also by the mouth. This finished, the glass eyes are inserted, as in other animals, and fixed by means of cement.

Many species of fish have semi-transparent cartilages connected with the eyes. These must be imitated with gum-arabic and powdered starch, as well as the cornea of the eyes.

The skins of all fish, which are similar to that of sharks, must be well supplied with spirits of turpentine, after they are mounted, more particularly the head and fins; but as they are not glossy, they do not require to be varnished.

When the fins are strong, it is necessary to keep them extended by means of a wire introduced through them.

In the diadons, the chief thing to be attended to, beyond what we have above stated, is, to take care that the spines, with which their skins are beset, are not broken or depressed in any way.

The fishing frog, *(lophius piscatorius)*, is very easily preserved, as the colors are not so liable to change as in many other species.

Salmon, trout, trench, carp, pike, &c. are very easily preserved, as the scales are firmly attached to the skin; and although they become somewhat dim from drying, their colors and brilliancy are considerably restored by means of varnish, if applied before they are thoroughly dried.

After a lapse of time, the varnish will rise into little scales: to remove these, nitric acid, diluted in water, must be applied to the whole external surface, which has the effect of completely taking off the varnish, or at least of raising it from the skin, which, when allowed to dry, can be wholly removed by rubbing it with a small brush. It may then be varnished again: when dry, it will ever afterwards continue quite solid.

The late Mr. Stutchbury had a method of preparing the fresh water fishes of Britain, which was much admired at the time. He skinned them under water, by which means he retained the scales in great perfection. But this method is too troublesome to be generally adopted.

What is above recommended, will apply to almost all fishes; but where there is any difficulty, it must be left to the ingenuity of the operator.

ACTION OF RUNNING WATER.

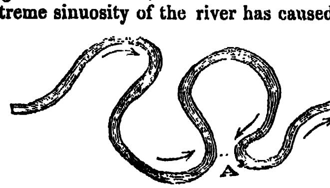
It is well known that the lands elevated above the sea attract, in proportion to their volume and density, a large quantity of that aqueous vapour which the heated atmosphere continually absorbs from the surface of lakes and the ocean. By these means, the higher regions become perpetual reservoirs of water, which descend and irrigate the lower valleys and plains. In consequence of this provision, almost all the water is first carried to the highest regions, and is then made to descend by steep declivities towards the sea; so that it acquires superior velocity, and removes a greater quantity of soil than it would do if the rain had been distributed over the plains and mountains equally in proportion to their relative areas. Almost all the water is also made by these means to pass over the greatest distances which each region affords, before it can regain the sea. The rocks also, in the higher regions, are particularly exposed to atmospheric influences, to frost, rain, and vapour, and to great annual alternations of cold and heat, of moisture and desiccation.

Among the most powerful agents of decay may be mentioned that property of water which causes it to expand during congelation; so that, when it has penetrated into the crevices of the most solid rocks, it rends them open on freezing with mechanical force. For this reason, although in cold climates the comparative quantity of rain which falls is very inferior, and although it descends more gradually than in tropical regions, yet the severity of frost, and the greater inequalities of temperature, compensate in some degree for this diminished source of degradation. The solvent power of water also is very great, and acts particularly on the calcareous and alkaline elements of stone, especially when it it holds carbonic acid in solution, which is abundantly supplied to almost every large river by springs, and is collected by rain from the atmosphere. The oxygen of the atmosphere is also gradually absorbed by all animal and vegetable productions, and by almost all mineral masses exposed to the open air. It gradually destroys the equilibrium of the elements of rocks, and tends to reduce into powder, and to render fit for soils, even the hardest aggregates belonging to our globe.

When earthy matter has once been intermixed with running water, a new mechanical power is obtained by the attrition of sand and pebbles, borne along with violence by a stream. Running water charged with foreign ingredients being thrown against a rock, excavates it by mechanical force, sapping and undermining till the superincumbent portion is at length precipitated into the stream. The obstruction causes a temporary increase of the water, which then sweeps down the barrier.

By a repetition of these landslips, the ravine is widened into a small, narrow valley, in which sinuosities are caused by the deflexion of the stream first to one side and then to the other. The unequal hardness of the materials through which the channel is eroded, tends partly to give new directions to the lateral force of excavation. When by these, or by accidental shiftings of the alluvial matter in the channel, and numerous other causes, the current is made to cross its general line of descent, it eats out a curve in the opposite bank, or in the side of the hills bounding the valley, from which curve it is turned back again at an equal angle, so that it recrosses the line of descent, and gradually hollows out another curve lower down in the opposite bank, till the whole sides of the valley, or river-bed, present a succession of salient and retiring angles. Among the causes of deviation from a straight course by which torrents and rivers tend in mountainous regions to widen the valleys through which they flow, may be mentioned the confluence of lateral torrents, swollen irregularly at different seasons by partial storms, and discharging at different times unequal quantities of debris into the main channel.

When the tortuous flexures of a river are extremely great, the aberration from the direct line of descent is often restored by the river cutting through the isthmus which separates two neighbouring curves. Thus, in the annexed diagram, the extreme sinuosity of the river has caused it to



return for a brief space in a contrary direction to its main course, so that a peninsula is formed, and the isthmus (at A) is consumed on both sides by currents flowing in opposite directions. In this case an island is soon formed, on either side of which a portion of the stream usually remains.

In regard to the transporting power of water, we may often be surprised at the facility with which streams of a small size, and descending a slight declivity, bear along coarse sand and gravel; for we usually estimate the weight of rocks in air, and do not reflect on their comparative buoyancy when submerged in a denser fluid. The specific gravity of many rocks is not more than twice that of water, and very rarely more than thrice, so that almost all the fragments propelled by a stream have lost a third, and many of them half, of what we usually term their weight.

It has been proved by experiment, in contradiction

to the theories of the earlier writers on hydrostatics, to be a universal law, regulating the motion of running water, that the velocity at the bottom of the stream is every where less than in any part above it, and is greatest at the surface. Also, that the superficial particles in the middle of the stream move swifter than those at the sides. This retardation of the lowest and lateral currents is produced by friction; and when the velocity is sufficiently great, the soil composing the sides and bottom gives way. A velocity of three inches per second at the bottom is ascertained to be sufficient to tear up fine clay,—six inches per second, fine sand,—twelve inches per second, fine gravel,—and three feet per second, stones of the size of an egg.

When this mechanical power of running water is considered, we are prepared for the transportation of large quantities of gravel, sand, and mud, by the torrents and rivers which descend with great velocity from mountainous regions. But a question naturally rises, how the more tranquil rivers of the valleys and plains, flowing on comparatively level ground, can remove the prodigious burden which is discharged into them by their numerous tributaries, and by what means they are enabled to convey the whole mass to the sea. If they had not this removing power, their channels would be annually choked up, and the valleys of the lower country, and plains at the base of mountain-chains, would be continually strewed over with fragments of rock and sterile sand. But this evil is prevented by a general law regulating the conduct of running water—that two equal streams do not, when united, occupy a bed of double surface. In other words, when several rivers unite into one, the superficial area of the fluid mass is far less than that usually occupied by the separate streams. The collective waters, instead of spreading themselves out over a larger horizontal space, contract themselves into a column of which the height is greater relatively to its breadth. Hence a smaller proportion of the whole is retarded by friction against the bottom and sides of the channel; and in this manner the main current is often accelerated in the lower country, even where the slope of the river's bed is lessened.

It not unfrequently happens, that two large rivers, after their junction, have only the *surface* which one of them had previously; and even in some cases their united waters are confined in a narrower bed than each of them filled before. By this beautiful adjustment, the water which drains the interior country, is made continually to occupy less room as it approaches the sea; and thus the most valuable part of our continents, the rich deltas, and great alluvial plains, are prevented from being constantly under water.

CURING OF PROVISIONS.

Flesh.—The ordinary means employed for preserving butcher's meat are, drying, smoking, salting, and pickling or souring.

Drying of Animal Fibre.—The best mode of operating is as follows:—The flesh must be cut into slices from 2 to 6 ounces in weight, immersed in boiling water for 5 or 6 minutes, and then laid on open trellis-work in a drying-stove, at a temperature kept steadily about 122° Fahr., with a constant stream of warm dry air. That the boiling water may not dissipate the soluble animal matters, very little of it should be used, just enough for the meat to be immersed by portions in succession, whereby it will speedily become a rich soup, fresh water being added only as evaporation takes place. It is advantageous to add a little salt, and some spices, especially coriander seeds, to the water. After the parboiling of the flesh has been completed, the soup should be evaporated to a gelatinous consistence, in order to fit it for forming a varnish to the meat after it is dried, which may be completely effected within two days in the oven. By this process two-thirds of the weight is lost. The perfectly dry flesh must be plunged piece by piece in the fatty gelatinous matter liquefied by a gentle heat; then placed once more in the stove, to dry the layer of varnish. This operation may be repeated two or three times, in order to render the coat sufficiently uniform and thick. Butcher's meat dried in this way, keeps for a year, affords, when cooked, a dish similar to that of fresh meat, and is therefore much preferable to salted provisions. The drying may be facilitated, so that larger lumps of flesh may be used, if they be imbued with some common salt immediately after the parboiling process, by stratifying them with salt, and leaving them in a proper pickling-tub for 12 hours before they are transferred to the stove. The first method, however, affords the more agreeable article.

Smoking.—This process consists in exposing meat previously salted, or merely rubbed over with salt, to wood smoke, in an apartment so distant from the fire as not to be unduly heated by it, and into which the smoke is admitted by flues at the bottom of the side walls. Here the meat combines with the empyreumatic acid of the smoke, and gets dried at the same time. The quality of the wood has an influence upon the smell and taste of the smoke-dried meat; smoke from the twigs and berries of juniper, from rosemary, peppermint, &c., imparts somewhat of the aromatic flavour of these plants. A slow smoking with a slender fire is preferable to a rapid and powerful one, as it allows the empyreumatic principles time to penetrate into the interior substance, without drying the outside too much. To prevent soot from attaching itself to the provisions, they may be wrapped in cloth, or rubbed over with bran, which may be easily removed at the end of the operation.

The process of smoking depends upon the action of the wood acid, or the creosote volatilized with it, which operates upon the flesh. The same change may be produced in a much shorter time by immersing the meat for a few hours in pyroligneous acid, then hanging it up to dry air, which, though moderately warm, makes it fit for keeping without any taint of putrescence. After a few days exposure, it loses the empyreumatic smell, and then resembles thoroughly smoked provisions. The meat dried in this way is in general somewhat harder than by the application of smoke, and therefore softens less when cooked, a difference to be ascribed to the more sudden and concentrated operation of the wood vinegar, which effects in a few hours what would require smoking for several weeks. By the judicious employment of pyroligneous acid diluted to successive degrees, we might probably succeed in imitating perfectly the effect of smoke in curing provisions.

Salting.—The meat should be rubbed well with common salt, containing about one sixteenth of saltpetre, and one thirty-secondth of sugar, till every crevice has been impregnated with it; then sprinkled over with salt, laid down for 24 or 48 hours, and, lastly, subjected to pressure. It must next be

sprinkled anew with salt, packed into proper vessels, and covered with the brine obtained in the act of pressing, rendered stronger by boiling down. For household purposes it is sufficient to rub the meat well with good salt, to put it into vessels, and load it with heavy weights, in order to squeeze out as much pickle as will cover its surface. If this cannot be had, a pickle must be poured on it, composed of 4 pounds of salt, 1 pound of sugar, and 2 ounces of saltpetre, dissolved in 2 gallons of water.

Pickling with Vinegar.—Vinegar dissolves or coagulates the albumen of flesh, and thereby counteracts its putrescence. The meat should be washed, dried, and then laid in strong vinegar. Or it may be boiled in the vinegar, allowed to cool in it, and then set aside with it in a cold cellar, where it will keep sound for several months.

Fresh meat may be kept for some months in water deprived of its air. If we strew on the bottom of a vessel a mixture of iron filings and flowers of sulphur, and pour over them some water which has been boiled, so as to expel its air, meat immersed in it will keep a long time, if the water be covered with a layer of oil, from half an inch to an inch thick. Meat will also keep fresh for a considerable period when surrounded with oil, or fat of any kind, so purified as not to turn rancid of itself, especially if the meat be previously boiled. This process is called potting, and is applied successfully to fish, fowls, &c.

Prehti says that living fish may be preserved 14 days without water, by stopping their mouths with crumbs of bread steeped in brandy, pouring a little brandy into them, and packing them in this torpid state in straw. When put into fresh water, they come alive again after a few hours!

Eggs.—These ought to be taken new laid. The essential point towards their preservation is the exclusion of the atmospheric oxygen, as their shells are porous, and permit the external air to pass inwards, and to excite putrefaction in the albumen. There is also some oxygen always in the air cell of the eggs, which ought to be expelled or rendered inoperative, which may be done by plunging them for five minutes in water heated to 140° Fahr. The eggs must be then taken out, wiped dry, besmeared with some oil (not apt to turn rancid) or other unctuous matter, packed into a vessel with their narrow ends uppermost, and covered with sawdust, fine sand or powdered charcoal, will keep fresh for a year. Lime-water, or rather milk of lime, is an excellent vehicle for keeping eggs in, as has been verified by long experience. Some persons coagulate the albumen partially, and also expel the air by boiling, the eggs for two minutes, and find the method successful. When eggs are intended for hatching, they should be kept in a cool cellar; for example, in a chamber adjoining an ice-house. Eggs exposed, in the holes of perforated shelves, to a constant current of air, lose about ¾ of a grain of their weight daily, and become concentrated in the albuminous part so as to be little liable to putrefy. For long sea voyages, the surest means of preserving eggs, is to dry up the albumen and yolk, by first triturating them into a homogeneous paste, then evaporating this in an air-stove or a water-bath, heated to 125°, and putting up the dried mass, in vessels which may be made air-tight. When used, it should be dissolved in three parts of cold or tepid water. (*To be continued.*)

CHEMICAL TESTS.

(*Resumed from page* 328.)

To detect Gold in Minerals.—Scrape the mass with the point of a knife; if it be gold, it will be soft, and may be cut like lead; or strike it gently with the small end of a hammer, if it be gold, it will be indented. Melt a small particle with the blow-pipe, if it be gold, its color will remain the same; but if it be brittle and hard to the knife and hammer, it is not gold. Place a few fragments upon a hot shovel, or under the flame of the blow-pipe, if the sulphur burn away, leaving scoria, that is attracted by the magnet; this proves that it is a combination of sulphur and iron, commonly called iron pyrites. Put a few of the particles into a watch-glass, and drop a little muriatic acid upon it, and hold it over the flame of a lamp or candle until it boils, if it is gold, no alteration will take place; but if not, effervescence and change of color will be the result, which shows that the substance is acted upon by the acid; the contents may now be thrown into a glass of water, into which let fall a few drops of prussiate of potass, the liquid will change to a beautiful blue. The iron pyrites being dissolved by the acid, will be thrown down in the state of Prussian blue.

Examination of Silver Ores.—A rich ore will be soft to the knife or hammer, and melt under the blow-pipe with little difficulty; and by repeated fusion with borax, a bead of silver may be produced.

A few small particles of the ore may be put into a watch-glass, into which drop a little nitrous acid; then hold it over the flame until it is dissolved. After this dilute it with water, and stir it about with a bright copper wire; if any silver is present, it will precipitate upon the copper, covering it with silver. Or add a little table salt to the solution; a white cloud of muriate of silver will fall down.

Native silver occurs in delicate curled fibres of a whitish color, in the cavities of quartz, and often surrounded by a black earthy substance. Sometimes these fibres are reticulated, or cross each other. This silver is oftentimes very brilliant and pure; when tried by the knife, it will be found harder than lead. It may be distinguished from tin, by being heavier, and by not crackling as tin does, when bent.

To discover Copper Ore in Minerals.—Place a small piece of supposed copper ore upon a piece of charcoal, with a little powdered borate of soda, (borax,) and direct the flame of a blow-pipe upon it. If it be rich ore, it will be reduced to a bead of pure copper, coloring the slag green, or reddish brown; it is sometimes necessary to repeat the fusion. Another method of detecting copper is as follows:

Reduce a small particle to powder; put it into a watch glass, with a few drops of nitrous acid; if no action takes place, apply a little heat, by holding it over the flame of a lamp; the copper will soon be acted upon, and dissolved by the acid. Now add a few drops of water, and stir it with the point of a knife, or any piece of clean iron. The copper will leave its solution, and precipitate upon the iron, covering it and giving it the appearance of copper. Or the contents of the watch-glass may be thrown into a glass of water; to this add a few drops of liquid ammonia, and it will become of a beautiful blue color.

Ores of copper have commonly a yellowish brown

appearance, the poorer ores much resembling pyrites, but they are softer to the knife. Copper ores, that are richer, are of a good yellow: some are irridescent, exhibiting a pretty and variable display of color, and are called peacock copper:—others are green, and in delicate fibres; sometimes compact, beautifully zoned, exhibiting great variety of lighter and darker shades; these are called malachite. copper ores are sometimes too, of a green, black or red color. Native copper is often found in veins in Cornwall.

Analysis of the Ore of Tin.—The ores of this metal may, after having been pulverized, and mixed with borax, be reduced to the metallic state; but care must be taken not to continue the heat too long, as it will burn away: a little soot, or soap, melted with it, will assist the operation. If this test is insufficient, the ore may be dissolved in a little nitro-muriatic acid, and precipitated of a yellow color, by pouring into the solution a little pure potass.

Tin ores may be known by their comparatively great weight; they are crystallized, and sometimes of a resinous color, but commonly approaching to black: tin also occurs in small massive striated pieces, called *wood tin.*

Test for the Purity of Alcohol.—It is a common practice for apothecaries, in order to ascertain if spirits of wine be sufficiently strong, to pour some into a cup upon gunpowder, and then to set fire to it. If the spirit be sufficiently strong, after burning down to the gunpowder, it will inflame; but if too much water had been mixed with it, that would not take place, as, after the spirit was consumed, there would still be water enough to keep the gunpowder wet.

(*To be continued.*)

COLORED SHADOWS.

To the Editor.

SIR.—I beg leave to communicate the following, as it appears to me to be somewhat extraordinary:—Upon entering a room last night, I observed that the moonbeam on the wall was slightly tinged with a blue color; the beam had passed through the window which was covered with foliated ice. I took a mirror, and placing it against the beam, obtained two reflections, one of which was slightly tinged with blue, and the other of a dusky white shade. I supposed the latter was given by the candle; I then extinguished it, and was surprised to see that the moonbeam on the wall was no longer tinged with blue, but possessed its own pure white light, unmixed. HIBERNICUS.

Belfast.

To the Editor.

SIR.—In consequence of the electricity of high pressure steam having of late attracted the attention of scientific persons, I beg leave to present to your readers the following suggestions respecting the cause by which the electric phenomena is produced. Assuming, in the first place, that steam becomes an electric or nonconductor the nearer it approaches a state of purity and freedom from moisture, which the experiments of Dr. Schafhaentl have confirmed, might we not at once compare the boiler of a steam engine to an electric machine? The friction produced by the steam issuing from the fissure in the boiler answering to the friction produced by the cylinder and rubber, consequently the steam issuing from the boiler will be charged with electricity in a greater or less degree dependent on the pressure exerted on the steam, the size of the fissure, as also the state of the atmosphere at the time. Again, on the steam condensing and occupying so small a space, the superabundant electricity will discharge itself by the nearest conductor, and if none be present to carry it off, it will descend to the ground by the moisture with which the atmosphere must be loaded. I would now remark, that this phenomena can be observed only with steam under a high pressure, as under the ordinary pressure of the atmosphere the moisture it contained, would render it a conductor of electricity. Subsequent experiments will, no doubt, set the matter at rest, though the pursuit will be that of curiosity rather than utility. With the best wishes for the success of your valuable periodical,

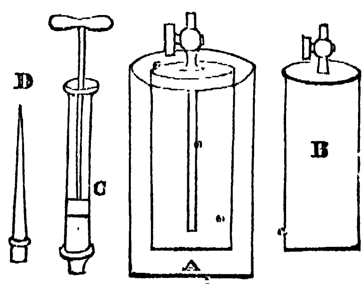
I am, your's respectfully,

Braintree. J. W. LAKE.

FIRE CLOUD.

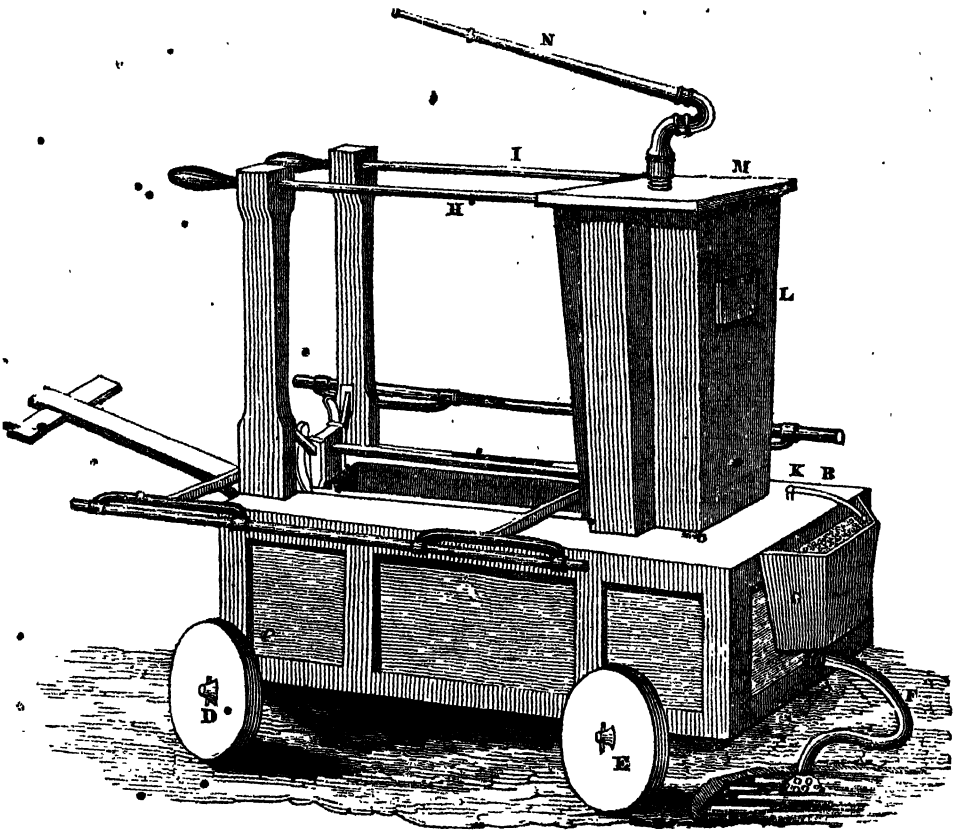
To the Editor.

SIR.—As no person has yet answered the 217th question, which was propounded in a former number of your Magazine, as to the method by which the fire-cloud at the Polytechnic Institution is produced, I send you a description as accurately as I can recollect of one I have seen, which is in the possession of a gentleman in Shropshire; and I presume that the one at the Polytechnic is of a similar construction.



The vessel A is composed of tin, and is so constructed that when the vessel B is placed in it, it shall be quite closed, there being an aperture at the top into which the vessel B exactly fits. B is a strong copper vessel of the shape represented in the drawing with a stop cock at the top, a screw being made at the top of the cock into which either the *condensing* syringe C, or the jet D will fit. When it is used, A is half filled with boiling water, B is about ¾ filled with a solution of muriate of copper and strontian or other coloring matter, in strong spirit of wine. The condensing syringe is then screwed on B, the air is condensed to such a degree, that when (by turning the cock) the jet is substituted for the syringe; the spirit is forced through the jet. The experiment must be conducted in a room with a low ceiling, against which the jet is to be directed. The spirit having been very much heated by the boiling water, by the time it reaches the ceiling is converted into vapour, which must be lighted by holding a sponge saturated with spirit and lighted towards it, when with a little management, a very beautiful appearance will be produced. J. H. B.

Fig. 1.



NEWSHAM'S FIRE ENGINE.

FIRE ENGINES.

When fire breaks out in a crowded neighbourhood, it carries with it such devastating effects, that any individual who has seriously turned his attention to the constructing of an engine, that is in the least calculated to check its progress, must ever be considered as deserving of our praise. One of those who have most beneficially directed their attention this way are Mr. Newsham, whose engine we shall proceed to describe.

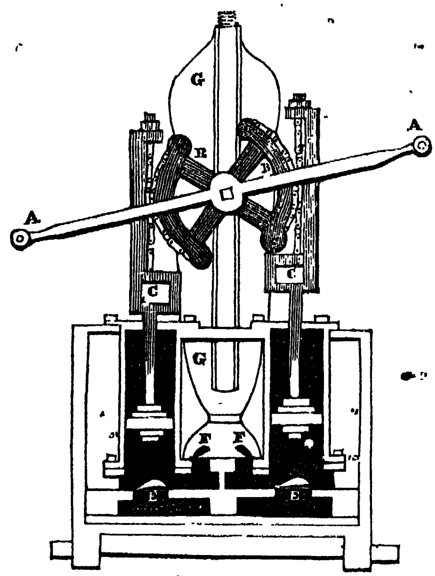
A perspective view of Mr. Newsham's fire-engine, ready for working, is represented in Fig. 1. It consists of a cistern, about three times as long as it is broad, made of thick oaken planks, the joints of which are lined with sheet copper, and easily moveable by means of a pole and cross-bar; the fore part of the engine, which is so contrived as to slip back under the cover of the cistern and on four solid wheels, two of which are seen at D and E. The hind axle-tree, to which the wheel E and its opposite are fixed, is fastened across under the bottom of the cistern; but the fore axle-tree, bearing the wheel D, &c. is put on a strong pin or bolt, strongly fastened in a horizontal situation in the middle of the front of the bottom of the cistern, by which contrivance the two forewheels and the axletree have a circular motion round the bolt, so that the engine may stand as firm on rough or sloping ground as if it were level.

Upon the ground next to the hind part of the engine may be seen a leather pipe F, one end of which may be screwed on and off upon occasion to a brass cock at the lower end of the cistern; the other end immersed in water, supplied by a pond, fire-plug, &c. and the pipe becomes a sucking-pipe for furnishing the pump of the engine by its working, without pouring water into the cistern. To the hind part of the cistern is furnished a wooden trough G, with a copper grate for keeping out stones, sand, and dirt, through which the cistern is supplied with water when the sucking-pipe cannot be used. The fore part of the cistern is also separated from the rest of its cavity by another copper grate, through which water may be poured into the cistern. Those that work the pumps of this engine move the handles, visible at the long sides, up and down, and are assisted by others who stand on two suspended treadles, throwing their weight alternately upon each of them, and keeping themselves steady, by taking hold of two round horizontal rails H I, framed into vertical stands which reach the bottom of the cistern, and are well secured to its sides.

Over the hind trough there is an iron handle or key K, serving to open or shut a cock placed under it on the bottom of the cistern. L is an inverted pyramidal case which preserves the pumps and air-vessels from damage, and also supports a wooden frame M, on which stands a man, who, by raising or depressing, and turning about the spout N, directs the stream of water as occasion requires. This spout is made of two pieces of brass pipe, each of which has an elbow; the lower is screwed over the upper end F, of the pipe that goes through the air-vessel, and the upper part screws on to the lower by a screw of several threads, so truly turned as to be water-tight in every direction. The conic form of the spouting pipe serves for wire-drawing the water in its passage through it, which occasions a friction that produces such a velocity of the jet as to render it capable of breaking windows, &c. whilst the valves and leather pipes of the engine have sufficient water-way to supply the jet in its greatest velocity. Leather pipes of considerable length may be screwed at one end of the nozzle of the engine, and furnished at one end with a wooden or brass pipe for guiding the water into the inner parts of houses.

Between the pyramid-box L, and the fore end of the engine, there is a strong iron bar O, lying in a horizontal position in the middle of the cistern, and playing in brasses supported by two wooden stands; one of them which P, is placed between the two fore stands of the upper rails, and the other is hid in the inclosure over the hind part. Upon proper squares of this bar are fitted, one near each end, two strong brass bars, which take hold of the long wooden cylindrical handles, by means of which the engine is worked; and the treadles by which they are assisted are suspended at each end by chains in the form of a watch-chain, and receive their motion jointly with the handles, that are on the same side, by means of two circular sectors of iron fastened together, and fixed upon proper squares of the middle horizontal bar; the two fore ones may be seen at Q; the two hind ones, represented upon a large scale in Fig. 2, differ from the former only in thickness, for the fore sectors are made to carry only one chain each, fastened by one end to their upper part, and by the lower end of the treadles; whereas the sole of the two hind sectors is wide enough to carry two chains each; one set fastened like those of the fore ones for the treadles; and the other chains are fastened by their lower ends to the lower part of these sectors, and by their upper ends to the top of the piston-bars, in order to give them motion. See Fig. 2, in which the hind sectors and their apparatus are represented as they would appear to a person standing between the two fore wheels, and looking at the hind part of the engine.

Fig. 2.



The square over the centre of the bar A A, Fig. 2, is the section of the middle bar, on which, right over the two barrels, are placed the two sectors B B and forged together. C C are the two piston-rods; and the openings at C C, are the spaces through which the hind parts of the two treadles pass. To each of the pistons is fastened a chain like a watch-chain, and fixed by their upper ends to the upper extremities D and B of the iron sectors, by which they are drawn up and down alternately.

The shape of the piston-rods, and the size and situation of the chains that give them motion, are so contrived, that the vertical axis of the pistons is exactly in the middle of the breadth of the perpendicular part of the chains, and the upper part of the piston-rod taken together. A A represents one of the cross-bars through the ends of which pass the handles to which the men apply their hands when they work the engine; these cross-bars are fitted on the middle bar at some distance from the sectors.

The principles on which this engine acts, so as to produce a continued stream, are obvious: the water being driven into the air-vessel, as in the operation of common sucking and forcing pumps, will compress the air contained in it, and proportionably increase its spring, since the force of the air's spring will be always inversely as the space which it possesses; therefore when the air-vessel is half filled with water, the spring of the included air, which in its original state counterbalanced the pressure of the atmosphere, being now compressed into half the space, will be equal to twice the pressure of the atmosphere; and by its action on the subjacent water will cause it to rise through the conduit pipe, and play a jet of 32 or 33 feet high, abating the effect of

friction. When the air-vessel is only two-thirds full of water,* the space which the air occupies is only one-third of its first space; therefore its spring being three times as great as that of the common air, will project the water with twice the force of the atmosphere, or to the height of 64 or 66 feet. In the same manner when the air-vessel is three-fourths full of water the air will be compressed into one-fourth of its original space, and cause the water to ascend in air with the force of three atmospheres, or to the height of 96 or 99 feet.

RESTORATION OF OIL PAINTINGS.

To restore pictures to their original freshness does not present any great difficulties when they only suffer from the varnish having become dark by time; but when, after a long course of years, they have been exposed carelessly to the action of unfavorable circumstances,—when the canvass is rent or half-rotten, when the joints of the panels are open, and the color is ready to fall off by the slightest touch, it would seem as if they were then past all cure. Yet, however great and imminent their destruction may appear, there is a method of saving them, by taking the picture off its ground, and laying it on a new canvass: this is called "lining the picture."

It is requisite to put a new cloth on the back of the picture when the latter is cut or torn, or even when the edges are so much worn as that they will not bear to be again nailed on the stretcher. In such cases it is probable that the picture may adhere firmly to the canvass; of course, it will be quite sufficient to glue the new cloth to the back of it.

In each case the operation is commenced by pasting some paper on the surface of the picture, that it may be handled without danger; and sometimes it is requisite to paste several sheets of thin tissue, one above another. If the old cloth is to be removed, it is of the first importance that the paper should adhere closely to the surface; therefore gauze paper is first to be pasted on, and this lets the air through so easily, that then there is a complete adhesion.

Should the picture be very dry, it will be proper to apply beneath, several couches of oil, mixed with a little spirits of turpentine; this will penetrate the dry mass, and secure the parts which are ready to drop off; but as the paste will not adhere to a greasy surface, it will be requisite, after having well washed the picture, to apply a weak solution of soda or potass, to remove the greasiness. The best paste which is employed in this operation is made with equal parts of Flanders glue and fine barley-meal. This mixture is preferred to that made of wheaten flour, as it keeps much longer soft, and is not so liable to crack. The paper should be very thin, and also very even and smooth, with little size in it.

Having thus securely fixed the picture, the operator next proceeds to remove the old canvass; this will not be difficult, should it have been prepared with paste previous to the priming. It will be sufficient, in that case, to moisten it with a wet sponge; the paste will soon dissolve, and the cloth can be easily removed. But if there is no paste under the priming, then the cloth must be removed by pumice stone or a fine file.

For the relining, the usual method is to strain a new and strong cloth of an even surface upon the stretcher, to rub it down smooth with pumice stone, and then to give it an even couch of paste, a similar couch is then to be applied to the back of the picture after it has been freed from all inequalities; it is then to be placed carefully upon the cloth, taking care to press it so gradually as to expel the air that would otherwise remain, and render the surface uneven; the pressure should be from the centre to the edges; when the paste is nearly dry, a smoothing iron should be passed over the surface; it must not be hot enough to endanger the picture, but sufficiently warm to melt the gelatine contained in the paste, which will thus be driven into all the fissures, and it securely binds the parts that are likely to scale off. The advantage of this operation is to render the surface of the picture even; the iron must therefore be passed over several times, beginning always at the edge, where the moisture remains longer on account of the frame impeding the action of the air; the picture is then to be placed in a dry room for some days, and nothing more is required than to detach the paper which had been pasted on the front of the picture; this must be done with a wet sponge.

In this operation, care must be taken that the dampness shall not raise the edges of the painting; this disadvantage would be obviated, by first pasting upon the edges of the frame some bands of paper, which would extend a little way on the surface of the picture.

It frequently happens, that when the paper is removed, some impressions of the margins of the paper remain on the surface of the picture, especially if the paper employed was of a strong kind; to get rid of these marks, it is requisite to paste some fresh paper, of a very thin and fine texture, over the picture, taking care that the new sheets shall be so laid on, that the middle part shall cover the old traces; and, in passing the iron over them, it should only be used above the part to be rendered smooth.

If the canvass be but slightly injured, it may be repaired without relining the picture, by fixing to the back of the injured part several strips of gauze, to be placed one above another, with a strong cement composed of ceruse, and very fat oil; then place upon the part, a piece of marble or board, with a weight to keep it even, and allow it to remain so for a day or two.

Should the picture happen to be on a panel, the same process of cartooning the surface with gauze and paper must be employed; when this is quite dry, the picture is to be laid flat upon a very smooth table, and by means of a tenon saw properly mounted, to prevent its edge from penetrating to the picture, the panel is then to be sawed into little squares, which are easily removed with a chisel; in this way the picture is gradually approached without danger; and, then by the use of a fine plane and files, the wood can be reduced to so thin a state, that by moistening it with a sponge, it can be easily removed, and the original distemper ground is thus uncovered; this ground is also to be removed, as it is commonly full of cracks; the relining is then to be completed as already described.

But when a panel is only damaged in some places, if the wood be sound, and the painting is partially in danger of scaling off, these local injuries may be remedied, without taking off the picture, by merely spreading over the bad parts some hot strong glue, which will penetrate through the cracks, and under the scales; when the size has set, all that remains

of it on the surface is to be removed, and paper is to be pasted on the part with thin paste, when dry a warm iron is pressed over it; this softens the size evenly under the loose parts, and makes them adhere solidly to the ground; with the glue an eighth part of white drying oil should be combined; this would render the parts less accessible to humidity.

When a panel is split or warped, the remedy is to glue at the back of it a sort of grating, made of deal; this is only glued in those parts which are in the direction of the grain of the panel; the cross bars are kept in their places by grooves made in their thickness; these are not glued on the panel, for they could not solidly adhere to it; but they serve by their pressure to sustain the surface, so as to prevent any further tendency to depression or warping.

The removal of a picture from a wall, is not attended with greater difficulties, except that it cannot be approached at the back as in other cases. When the front of the picture is properly cartooned, a groove is to be made in the surface of the wall around the picture, large enough to allow of a chisel being admitted, to detach the cement on which the picture is painted from the wall; this plaister is not more than from two to three inches in thickness; it is easily separated from the wall, and adheres closely to the picture.

As the cement separates from the wall, the picture is rolled on a large cylinder, to be removed; the cement adhering to the picture, is then to be carried off by the help of a chisel, and is an operation requiring much patience and great skill.

Should the picture have been painted upon the stone, without the intervention of mortar, it still may be taken off in the same way that trees are barked, with the aid of a chisel indented like a saw, and whetted in such a way that its edges will slowly penetrate the edge of the wall.

(To be continued.)

BRONZING MEDALS AND COINS.

Coins and medals may be handsomely bronzed as follows: 2 parts of verdigris and 1 part of sal ammoniac are to be dissolved in vinegar; the solution is to be boiled, skimmed, and diluted with water till it has only a weak metallic taste, and upon further dilution lets fall no white precipitate. This solution is made to boil briskly, and is poured upon the objects to be bronzed, which are previously made quite clean, particularly free from grease, and set it in another copper pan. This pan is to be put upon the fire, that the boiling may be renewed. The pieces under operation must be so laid that the solution has free access to every point of their surface. The copper hereby acquires an agreeable reddish brown hue, without losing its lustre. But if the process be too long continued, the coat of oxide becomes thick, and makes the objects appear scaly and dull. Hence they must be inspected every five minutes, and be taken out of the solution the moment their color arrives at the desired shade. If the solution be too strong, the bronzing comes off with friction, or the copper gets covered with a white powder, which becomes green by exposure to air, and the labour is consequently lost. The bronzed pieces are to be washed with many repeated waters, and carefully dried, otherwise they would infallibly turn green. To give fresh made bronze objects an antique appearance, three quarters of an ounce of sal ammoniac, and a dram and a half of binoxalate of potash (salt of sorrel) are to be dissolved in a quart of vinegar, and a soft rag or brush moistened with this solution is to be rubbed over the clean bright metal, till its surface becomes entirely dry by the friction. This process must be repeated several times to produce the full effect; and the object should be kept a little warm. Copper acquires very readily a brown color by rubbing it with a solution of the common liver of sulphur, or sulphuret of potash.

The Chinese are said to bronze their copper vessels by taking 2 ounces of verdigris, 2 ounces of cinnabar, 5 ounces of sal ammoniac and 5 ounces of alum, all in powder, making them into a paste with vinegar, and spreading this pretty thick like a pigment on the surfaces previously brightened. The piece is then to be held a little while over a fire, till it becomes uniformly heated. It is next cooled, washed, and dried; after which it is treated in the same way once and again till the wished-for color is obtained. An addition of sulphate of copper makes the color incline more to chesnut brown, and of borax more to yellow. It is obvious that the cinnabar produces a thin coat of sulphuret of copper upon the surface of the vessel, and might probably be used with advantage by itself.

To give the appearance of antique bronze to modern articles, we should dissolve 1 part of sal ammoniac, 3 parts of common salt in 12 parts of hot water, and mix with the solution 8 parts of a solution of nitrate of copper of specific gravity 1·160. This compound, when applied repeatedly in a moderately damp place to bronze, gives it in a short time a durable green coat, which becomes by degrees very beautiful. More salt gives it a yellowish tinge, less salt a bluish cast. A large addition of sal ammoniac accelerates the operation of the mordant.

NEW APPLICATIONS OF ELECTRICITY.

We extract from the *John O'Groat's Journal* the following account of two new applications of electrical power; the one to the regulation of time, the other to telegraphic printing. The invention of the clock has been patented, and is already at work; of the printing we have seen specimens; and we understand Mr. Bain intends opening an exhibition in London, for the purpose of making it more generally known.

"We have seen some late communications from London, by which we are gratified to perceive that one of our countrymen, Mr. Alexander Bain, from the parish of Watten, an ingenious mechanic, now employed in the metropolis, and who served his apprenticeship in this place to the watch and clock-making business with Mr. Sellar, is likely to succeed in two very extraordinary inventions. The first is in the art of clock-making. It would appear that Mr. Bain has established a method of making clocks to work by electricity—the great advantages of the new plan being, that in any number of clocks regulated by the same power, not the slightest alteration or difference of time will occur, while the expense will not come to more than one-third of the present price of clocks. Any number of clocks can be guided on the same principle; and as not one-hundredth part of a second of difference in time will be perceptible between them for a twelvemonth together, the benefit of this new invention, when perfected, will be particularly felt in large towns, in which there may be a number

of clocks, public and private. Indeed, it is questionable if the principle of electricity can be made to bear with any profitable result in a place in which there are not a number of clocks, the expense of directing one or two on the system referred to, though perfectly practicable, not admitting of its execution. We understand that a patent for the invention is to be applied for. The electrical power for the working of the clocks is to be conveyed by wires, which will be made to branch off, much on the same principle as gas-pipes. The machinery in these clocks will, it is said, require no winding up. The other invention of our industrious countryman, to which we beg to call the attention of our readers, is what he calls the "Electrical Helix Printing Press." Our London correspondent, who has addressed us on this subject, seems persuaded that it will altogether supersede the use of telegraphs, as by means of it, intelligence can be printed in an instant at a distance of many hundred miles from the place from which it may be wished to convey it. In order to give some idea of the rapidity with which this press will be enabled to work, our correspondent adds—"Metallic wires are required to be laid between the places from which intelligence is to be conveyed and those at which it is desired to announce it, and provided a press be placed at each termination of these wires, and that they were made to extend, if you will, from London to Wick, any information could be conveyed from the one place to the other with a celerity which would set all previous inventions at defiance."—*Inventors' Advocate.*

CURING OF PROVISIONS.

(Resumed from page 383, and concluded.)

Grain of all kinds, as wheat, barley, rye, &c., and their flour, may be preserved for an indefinite length of time, if they be kiln-dried, put up in vessels or chambers free from damp, and excluded from the air. Well-dried grain is not liable to the depredations of insects.

To preserve fruits in a fresh state, various plans are adopted. Pears, apples, plums, &c., should be gathered in a sound state, altogether exempt from bruises, and plucked in dry weather, before they are fully ripe. One mode of preservation is, to expose them in an airy place to dry a little for eight or ten days, and then to lay them in dry sawdust or chopped straw, spread upon shelves in a cool apartment, so as not to touch each other. Another method consists in surrounding them with fine dry sand in a vessel which should be made air-tight, and kept in a cool place. Some persons coat the fruit, including their stalks, with melted wax; others lay the apples, &c., upon wicker-work shelves in a vaulted chamber, and smoke them daily during four or five days with vine branches or juniper wood. Apples thus treated, and afterwards stratified in dry sawdust, without touching each other, will keep fresh for a whole year.

The drying of garden fruits in the air, or by a kiln, is a well-known method of preservation. Apples and pears of large size should be cut into thin slices. From five to six measures of fresh apples, and from six to seven of pears, afford in general one measure of dry fruit, (biffins.) Dried plums, grapes, and currants are a common article of commerce.

Herbs, cabbages, &c., may be kept a long time in a cool cellar provided they are covered with dry sand. Such vegetables are in general preserved for the purposes of food, by means of drying, salting, pickling with vinegar, or beating up with sugar. Cabbages should be scalded in hot water previously to drying; and all such plants, when dried, should be compactly pressed together, and kept in air-tight vessels. Tuberous and other roots are better kept in an airy place, where they may dry a little without being exposed to the winter's frost.

A partial drying is given to various vegetable juices by evaporating them to the consistence of a syrup, called a rob, in which so much of the water is dissipated as to prevent them from running into fermentation. The fruits must be crushed, squeezed in bags to expel the juices, which must then be inspissated either over the naked fire, or on a water or steam bath, in the air or in vacuo. Sometimes a small proportion of spices is added, which tends to prevent mouldiness. Such extracts may be conveniently mixed with sugar into what are called conserves.

Salting is employed for certain fruits, as small cucumbers or gherkins, capers, olives, &c. Even for peas such a method is had recourse to, for preserving them a certain time. They must be scalded in hot water, put up in bottles, and covered with saturated brine, having a film of oil on its surface, to exclude the agency of the atmospheric air. Before being used, they must be soaked for a short time in warm water, to extract the salt. The most important article of diet of this class, is the *sour kraut* of the northern nations of Europe, (made from white cabbage,) which is prepared simply by salting; a little vinegar being formed spontaneously by fermentation. The cabbage must be cut into small pieces, stratified in a cask along with salt, to which juniper berries and carui seeds are added, and packed as hard as possible by means of a wooden rammer. The cabbage is then covered with a lid, on which a heavy weight is laid. A fermentation commences, which causes the cabbage to become more compact, while a quantity of juice exudes and floats on the surface, and a sour smell is perceived towards the end of the fermentation. In this condition the cask is transported into a cool cellar, where it is allowed to stand for a year; and indeed, where, if well made and packed, it may be kept for several years.

The excellent process for preserving all kinds of butcher's meat, fish, and poultry, first contrived by M. Appert in France, and afterwards successfully practised upon the great commercial scale by Messrs. Donkin and Gamble, for keeping beef, salmon, soups, &c. perfectly fresh and sweet for exportation from this country, as also turtle for importation thither from the West Indies, deserves a brief description.

Let the substance to be preserved be first par-boiled, or rather somewhat more, the bones of the meat being previously removed. Put the meat into a tin cylinder, fill up the vessel with seasoned rich soup, and then solder on the lid, pierced with a small hole. When this has been done, let the tin vessel thus prepared be placed in brine and heated to the boiling point, to complete the remainder of the cooking of the meat. The hole of the lid is now to be closed perfectly by soldering, whilst the air is rarefied. The vessel is then allowed to cool, and from the diminution of the volume, in consequence of the reduction of temperature, both ends of the cylinder are pressed inwards, and become

concave. The tin cases, thus hermetically sealed, are exposed in a test-chamber, for at least a month, to a temperature above what they are ever likely to encounter, from 90° to 110° of Fahrenheit. If the process has failed, putrefaction takes place, and gas is evolved, which, in process of time, will cause both ends of the case to bulge, so as to render them convex, instead of concave. But the contents of those cases which stand the test will infallibly keep perfectly sweet and good in any climate, and for any number of years. If there be any taint about the meat when put up, it inevitably ferments, and is detected in the proving process. Mr. Gamble's turtle is delicious.

This preservative process is founded upon the fact, that the small quantity of oxygen contained within the vessel gets into a state of combination, in consequence of the high temperature to which the animal substances are exposed, and upon the chemical principle, that free oxygen is necessary as a ferment to commence or give birth to the process of putrefaction.

STAINING PAPER.

Yellow.—Paper may be stained a beautiful yellow by the tincture of turmeric formed by infusing an ounce or more of the root, powdered, in a pint of spirit of wine. This may be made to give any tint of yellow, from the lightest straw to the full color, called French yellow, and will be equal in brightness even to the best dyed silks. If yellow be wanted of a warmer or redder cast, anatto, or dragon's blood, must be added. The best manner of using these, and the following tinctures, is to spread them even on the paper, or parchment, by means of a broad brush, in the manner of varnishing.

Crimson.—A very fine crimson stain may be given to paper by a tincture of the Indian lake, which may be made by infusing the lake some days in spirit of wine, and then pouring off the tincture from the dregs. It may be stained red by red ink. It may also be stained of a scarlet hue by the tincture of dragon's blood in spirit of wine but this will not be bright.

Green.—Paper or parchment may be stained green, by the solution of verdigris in vinegar, or by the crystals of verdigris dissolved in water.

Orange.—Stain the paper or parchment first of a full yellow, by means of the tincture of turmeric; then brush it over with a solution of fixed alkaline salt, made by dissolving half an ounce of pearl-ash, or salt of tartar, in a quart of water, and filtering the solution.

Purple.—Paper or parcnment may be stained purple, by archil, or by the tincture of logwood. The juice of ripe privet berries expressed will likewise give a purple dye.

CONSTITUTION OF HEAT.

Calorific repulsion has been accounted for by supposing a subtle fluid capable of combining with bodies, and of separating their parts from each other, which has been named the *matter of heat or caloric.*

Many chemical phenomena admit of a happy explanation on this idea, such as the cold produced during the conversion of solids into fluids or gases, and the increase of temperature connected with the condensation of gases and fluids. In the former case, we say the matter of heat is absorbed or combined; in the latter it is extended or disengaged from combination. But there are other facts which are not so easily reconciled to the opinion. Such are the production of heat by friction and percussion; and some of the chemical changes which have been just referred to. These are the violent heat produced in the explosion of gunpowder, where a large quantity of aeriform matter is disengaged; and the fire which appears in the decomposition of the euchlorine gas, or protoxide of chlorine, though the resulting gases occupy a greater volume.

When the temperature of bodies is raised by friction, there seems to be no diminution of their capacities, using the word in its common sense; and in many chemical changes, connected with an increase of temperature, there appears to be likewise an increase of capacity. A piece of iron made red-hot by hammering, cannot be strongly heated a second time by the same means, unless it has been previously introduced into a fire. This fact has been explained by supposing, that the fluid of heat has been pressed out of it, by the percussion, which is recovered in the fire; but this is a very rude mechanical idea: the arrangements of its parts are altered by hammering in this way, and it is rendered brittle. By a moderate degree of friction, as would appear from Rumford's experiments, the same piece of metal may be kept hot for any length of time; so that if heat be pressed out, the quantity must be inexhaustible. When any body is cooled, it occupies a smaller volume than before; it is evident, therefore, that its parts must have approached to each other; when the body is expanded by heat, it is equally evident that its parts must have separated from each other. The immediate cause of the phenomena of heat, then, is motion, and the laws of its communication are precisely the same as the laws of the communication of motion. Since all matter may be made to fill a smaller volume by cooling, it is evident that the particles of matter must have space between them; and since every body can communicate the power of expansion to a body of a lower temperature, that is, can give an expansive motion to its particles, it is a probable inference that its own particles are possessed of motion; but, as there is no change in the position of its parts as long as its temperature is uniform, the motion, if it exist, must be a vibratory or undulatory motion, or a motion of the particles round their axes, or a motion of particles round each other.

It seems possible to account for all the phenomena of heat, if it be supposed that in solids the particles are in a constant state of vibratory motion, the particles of the hottest bodies moving with the greatest velocity, and through the greatest space; that in liquids and elastic fluids, besides the vibratory motion, which must be conceived greatest in the last, the particles have a motion round their own axes, with different velocities, the particles of elastic fluids moving with the greatest quickness, and that in ethereal substances; the particles move round their own axes, and separate from each other, penetrating in right lines through space. Temperature may be conceived to depend upon the velocities of the vibrations; increase of capacity on the motion being performed in greater space; and the diminution of temperature, during the conversion of solids into fluids or gases, may be explained on the idea of the loss of vibratory motion, in consequence of the revolution of particles round their axes, at the moment when the body becomes liquid or aeriform; or from the loss of rapidity of vibration, in

consequence of the motion of the particles through greater space.

If a specific fluid of heat be admitted, it must be supposed liable to most of the affections which the particles of common matter are assumed to possess, to account for the phenomena; such as losing its motion when combining with bodies, producing motion when transmitted from one body to another, and gaining projectile motion when passing into free space; so that many hypotheses must be adopted to account for its agency, which renders this view of the subject less simple than the other. Very delicate experiments have been made, which show that bodies, when heated, do not increase in weight. This, as far as it goes, is an evidence against a subtle elastic fluid, producing the calorific expansion; but it cannot be considered as decisive, on account of the imperfection of our instruments? A cubical inch of inflammable air requires a good balance to ascertain that it has any sensible weight, and a substance bearing the same relation to this, that this bears to platinum, could not perhaps be weighed by any method in our possession.—SIR H. DAVY.

ON THE PROBABLE DURATION OF THE PRESENT SUPPLY OF COAL.

THE vast importance of coal to the arts, manufactures, and general prosperity of our country, renders, in all its bearings, the trade in that material a subject of deep interest to all who justly estimate the sources of the greatness, commercial and otherwise, of the United Kingdom. It is true that without an enterprising spirit equal to making the most of the advantages we possess, we should still value our coal only as an article of simple fuel. The duration of the supply at the present rate is also a question which has occupied the attention of some of the most experienced geologists, but the investigations hitherto effected for the purpose of determining the extent of the coal beds in their various localities, are too indefinite to afford grounds for a solution approximating in probability to the truth. It is, however, a well-assured fact, that for a great many centuries to come the supply of coal will be equal to the demand. The most accurate calculations of the annual consumption of coal in Great Britain and Ireland, affords an amount of about 15,580,000 tons: but to arrive at the sum of the gross draught from the mines, the quantity exported must be added to this. With respect to the extent of the coal fields, it is the opinion of Mr. Taylor, a coal owner of much experience, that those of Durham and Northumberland are sufficiently stored to meet the present supply for a term yet to come of 1,700 years. Dr. Buckland, the distinguished geologist, dissents from this calculation as too exaggerated, but coincides with Bakewell in the statement that in South Wales alone, there are coal strata which will meet the present annual demand for a future period of 2,000 years. We are therefore free to believe that we have not as yet skimmed the surface of our treasured wealth, and we are well assured that many of the various uses to which coal is now applied are of recent date; and when it is remembered that scarcely more than 250 years have gone by since coal was first used in London, we may hazard a conjecture that one century of the current consumption, foreign and domestic, would cover that of the six centuries and a half which have passed away since the discovery of coal. We have spoken exclusively of other vast stores distributed in other parts of England and in Scotland; but without even taking these into account, we may question, to speak mildly, the sound judgment, at any period of peace, in the imposition of a heavy duty on the exportation of this precious mineral, on the plea of an apprehended exhaustion of the mines.

With respect to a natural and abundant supply of coal, Britain has been most singularly favored among the nations, since so much of the surface of the country conceals beneath it continuous and thick beds of this now indispensable fossil—and much more valuable is it to us than could have been the mines of Peru and Mexico; for coal, in the sole instance of its ministry to the steam engine, is an amount of power applicable in some way to almost every purpose that human labour can accomplish. It is the possession of coal mines that has rendered these kingdoms the mart of the world, as dispensing abroad the richest productions of art and industry; and with respect to the apprehended failure of these mines of real wealth and substantial power, it would afford by no means a just conclusion to calculate the future domestic consumption as at all likely to increase after a ratio deduced from an average of the last twenty years; since each day's experience brings with its suggestions, that as the arts of life advance, they may operate to economise the store, and yet forward every desirable end.

A seam or bed of coal is a definite stratum, and is found to be as regular as any of the other strata distributed throughout the coal fields, or indeed as much so as any of which the superfices of the globe is composed. There are, in many coal countries, beds of coal of various qualities and thickness deposited *stratum super stratum*, and sometimes different veins of coal formed so near to each other, that two or more are worked in the same pit. Every stratum of coal (to use a technicality) *dips*, that is, descends obliquely from the surface, and extends in every way as far as the other deposits by which it is accompanied; therefore every seam of coal bears its proportion in the formation of the superfices of the earth, and is coeval with the other strata with which it is found associated. A bed of coal does not always preserve a quality so equal near the surface as other deposits of a harder texture. Limestone, basaltes, and other less yielding substances, retain every distinguishing property even to the surface, but it is the character of strata of softer composition, when near the surface, to crack, crumble, and suffer dissolution into minute particles, which are mixed with the soil, or carried off by water. That layer which has been deposited immediately above a vein of coal is called its *roof*; and that upon which it is settled is called the *pavement*; and these deposits preserve, universally, their parellelism with regard to each other—they coincide in the same space and in the same inclined plane.

Had our remote ancestors even known that stores of a substance so valuable were deposited underground, the inefficiency of their means, and the abundance of fuel which wood and turf afforded them, would have deterred their digging so deep into the earth for that with which its surface supplied them. Even when wood became scarce, after a lapse of many centuries from the period of the discovery of coal, the manner of working it was extremely rude, and the progress and extent of its use slow and limited. At the commencement of the sixteenth century coal smoke was deemed highly prejudicial: and even at the end of it the use of coal

in working iron was scarcely known in Scotland. Although the discovery of coal is not very remote, yet has the working of it been extremely slow in its progress to its present state of perfection; for it was certainly not discovered in the middle of the twelfth century, and it was as certainly known at the beginning of the thirteenth. The earliest mention of coal occurs in the year 1234, when Henry III. renewed a charter which his father had granted to the inhabitants of Newcastle-upon-Tyne. In this instrument he confers upon individuals of the community in whose favor it was conceived, a license to dig coals upon payment of one hundred pounds a year. By the end of the thirteenth century the value and properties of this fossil were becoming so well known that it was frequently shipped for distant ports. Enæas Silvius, who afterwards assumed the purple as Pius II., and visited this island about the middle of the fifteenth century, relates that in Scotland he saw the poor begging at the doors of the churches, and the alms that they received were pieces of *black stone*, with which they were satisfied. "This species of stone," he continues, "impregnated with sulphur or some other inflammable matter, is burnt instead of wood, of which the country is destitute." It is probable that in China coal was known long before it was familiar to the Western world. About the middle of the thirteenth century, a noble Venetian, in his description of China, observes, that throughout the province of Cathay certain black stones are dug out of the mountains, which, being put in the fire, burn like wood, and when once kindled continue to burn for a length of time, insomuch that, being lighted in the evening, the fire will burn all night.

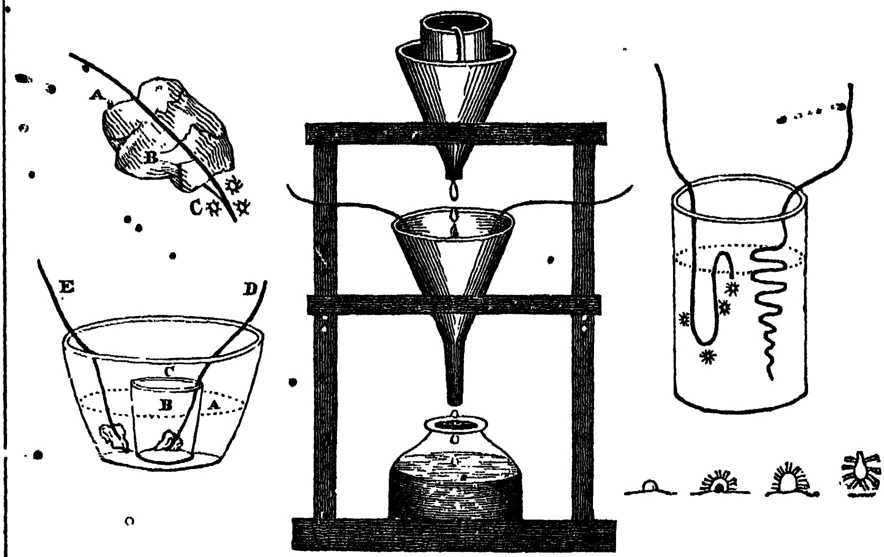
We can have little hesitation in determining the discovery of coal to have taken place between the middle of the twelfth century and the beginning of the thirteenth; and although it is perhaps six centuries and a half since this event took place in Britain, yet it is not more than 250 years since it has been commonly used as fuel, and even less than that time since it has been employed as such in London.

Coal beds, or strata, lie among those of gravel, sand, chalk, clay, &c., which form a great part of the surface of the earth, and have been accidentally accumulated during remote ages by the agency of moving water, similarly to those accumulations now in process of formation at the mouths of all great rivers, and at the bottoms of lakes and seas. When these strata had, by long contact and pressure, been consolidated into a kind of indurated crust to the earth, this crust, by subsequent convulsions of nature, of which innumerable other proofs remain, has been in various parts broken and heaved up above the level of the sea, so as to form the greater part of our dry or habitable land, in some parts appearing as lofty mountains, in others as extended plains. In some parts, fractures of the crust exhibit the edges of the various distinct strata, discoverable in a given thickness. When a division has taken place to any depth, these strata are discernible ranged in order above each other, and it may be presumed that at such fractures man first discovered coal and the other mineral products of the earth. Before the discovery of coal mines, or a cheap method of working them, wood was generally used as fuel in Great Britain, as it is now so generally used on the continent. Coal and wood are called *carbon*, and for their other important ingredient that *hydrogen*, which, when separated, exists in the form of air or gas. The hydrogen is easily driven off or volatilized from either coal or wood, by heating in a close place, and when caught and preserved, it forms the gas now employed to light the streets, &c. That part of coal which remains after having been subjected to this process is called *coke;* and the residue of wood similarly treated is called *charcoal;* both of which substances are almost pure carbon, but differing in their degrees of compactness. These kindred natures of coal and wood are not surprising, when it is known that much of our coal is transformed wood; many coal mines being evidently the remains of antediluvian forests swept together in the course of great and progressive terrestrial changes, and afterwards consolidated to the state now seen. This fact is so well known that it is scarcely necessary to allude to it here; and it is moreover incontrovertible since the species of the plants and trees which formed these beds are very commonly discovered in various stages of their chemical change, frequently mixed with the remains of animals which inhabited the earth at the same time. Ireland is naturally ill supplied with this kind of fuel, although coal is there in process of formation, but before the change be matured, a long series of centuries must work incalculable revolutions on the surface of the earth. We allude to the peat bogs, for peat is coal, only awaiting the final elaborations of natural chemistry. *(To be continued.)*

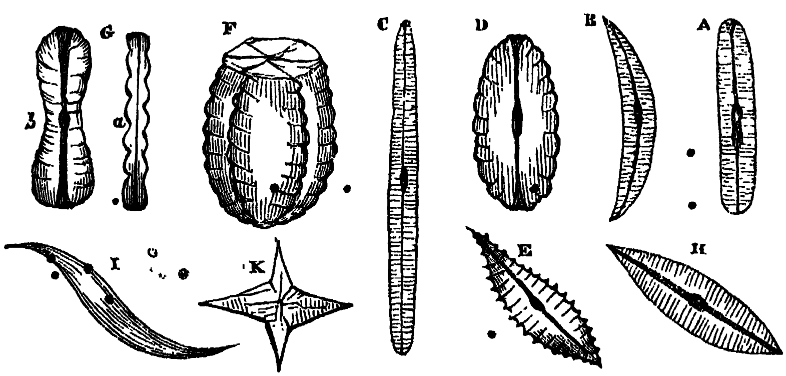
Sculpturing in Wood.—The following account of a new process for sculpturing in wood, invented by Messrs. Frantz and Graenaker, is translated from *Le Fanal.*

In this process, by means of which bas-reliefs, and large and small objects, are accurately sculptured, and for the application of which M. Graenaker already possesses models which admit of his undertaking extensive works, the wood employed is burnt or converted into charcoal. This effect is obtained by means of a strong pressure; for which a lever is used for multiplying the power five times, the action of which lasts about twenty seconds, and by an iron mould made red hot. The layer of charcoal formed ought not to be more than from two to three millimetres, and should easily separate on the application of a brush. The wood ought previously to be steeped in water, and the burning mould should act intermittingly, in order to allow the steam which is formed to escape, the expansion of which might remove some pieces of the wood and injure the work. After burning for twenty seconds, the wood is removed from the pressure, and thrown into water, to stop the burning of the charcoal, and to facilitate its dispersion on the application of the brush. By repeating the operation as many times as the depth of the mould requires, a figure in relief is obtained, which re-produces the impression of the original model with accuracy and neatness. The operation becomes more easy in proportion to the sponginess of the wood; consequently the commonest woods are best adapted for sculpturing objects by this process. Their durability is also very considerably increased, and the appearance of the sculptures produced in this manner from the poplar or from the chestnut tree, bears a strong resemblance to the wood of an old walnut tree, and the effect is very pleasing. A gold medal has been awarded to Messrs. Graenaker and Frantz.

3. *Fig.* 1. 2.



CROSSE'S GALVANIC EXPERIMENTS.



FOSSIL INFUSORIA.

MR. CROSSE'S GALVANIC EXPERIMENTS.

MANY of our readers are doubtless aware that two or three years since, a strong commotion was occasioned in the scientific world, by an account that Mr. Crosse had succeeded in producing animal life, by his long-continued and powerful galvanic experiments. Although there appears but little doubt that the utmost which the power employed accomplished, was nothing but the development of some vital germ, which existed previously in the substances employed, yet the experiments are so curious, and independent of this particular result, show so admirable a method of making, by means of galvanic agency, various mineral products, as Mr. Crosse is in the constant habit of doing by means of the same apparatus, that we imagine the insertion of Mr. Crosse's own account of his experiments cannot fail to gratify numbers of our readers. The following is therefore abridged from a letter sent some time since to the Electrical Society of London:—

"In the course of my endeavours to form artificial minerals by a long-continued electric action on fluids, holding in solution such substances as were necessary to my purpose, I had recourse to every variety of contrivance which I could think of, so that, on the one hand, I might be enabled to keep up a never-failing electrical current of greater or less intensity, or quantity, or both, as the case seemed to require; and, on the other hand, that the solutions made use of, should be exposed to the electric action in the manner best calculated to effect the object in view. Amongst other contrivances, I constructed a wooden frame, of about two feet in height, consisting of four legs proceeding from a shelf at the bottom supporting another at the top, and containing a third in the middle, (seen in section in Fig. 1.) Each of these shelves was about seven inches square. The upper one was pierced with an aperture, in which was fixed a funnel of Wedgewood ware, within which rested a quart basin on a circular piece of mahogany placed within the funnel. When this basin was filled with a fluid, a strip of flannel wetted with the same, was suspended over the edge of the basin and inside the funnel, which acting as a syphon, conveyed the fluid out of the basin, through the funnel, in successive drops. The middle shelf of the frame was likewise pierced with an aperture, in which was fixed a smaller funnel of glass, which supported a piece of somewhat porous red oxide of iron from Vesuvius, immediately under the dropping of the upper funnel. This stone was kept constantly electrified by means of two platina wires on either side of it, connected with the poles of a Voltaic battery of nineteen pairs of five-inch zinc and copper single plates, in two porcelain troughs, the cells of which were filled at first with water and 1-500th part of hydrochloric acid, but afterwards with water alone. I may here state, that in all my subsequent experiments relative to these insects, I filled the cells of the batteries employed with nothing but common water. The lower shelf merely supported a wide-mouthed bottle, to receive the drops as they fell from the second funnel. When the basin was nearly emptied, the fluid was poured back again from the bottle below into the basin above, without disturbing the position of the stone. It was by mere chance that I selected this volcanic substance, choosing it from its partial porosity; nor do I believe that it had the slightest effect in the production of the insects to be described. The fluid with which I filled the basin was made as follows:—

"I reduced a piece of black flint to powder, having first exposed it to a red-heat and quenched it in water to make it friable. Of this powder I took two ounces, and mixed them intensely with six ounces of carbonate of potassa, exposed them to a strong heat for fifteen minutes in a black lead crucible in an air furnace, and then poured the fused compound on an iron plate, reduced it to powder while still warm, poured boiling water on it, and kept it boiling for some minutes in a sand bath. The greater part of the soluble glass thus fused was taken up by the water, together with a portion of alumina from the crucible. I should have used one of silver, but had none sufficiently large. To a portion of the silicate of potassa thus fused, I added some boiling water to dilute it, and then slowly added hydrochloric acid to supersaturation. A strange remark was made on this part of the experiment at the meeting of the British Association at Liverpool, it being then gravely stated, that it was impossible to add an acid to a silicate of potassa without precipitating the silica! This, of course, must be the case, unless the solution be diluted with water. My object in subjecting this fluid to a long-continued electric action through the intervention of a porous stone, was to form, if possible, crystals of silica at one of the poles of the battery, but I failed in accomplishing this by those means. On the fourteenth day from the commencement of the experiment, I observed, through a lens, a few small whitish excrescences or nipples projecting from about the middle of the electrified stone, and nearly under the dropping of the fluid above. On the eighteenth day these projections enlarged, and seven or eight filaments, each of them longer than the excrescence from which it grew, made their appearance on each of the nipples. On the twenty-second day these appearances were more elevated and distinct, and on the twenty-sixth day each figure assumed the form of a perfect insect, standing erect on a few bristles which formed its tail. Till this period I had no notion that these appearances were any other than an incipient mineral formation; but it was not until the twenty-eighth day, when I plainly perceived these little creatures move their legs that I felt any surprise, and I must own that when this took place, I was not a little astonished. I endeavoured to detach with the point of a needle, one or two of them from its position on the stone, but they immediately died, and I was obliged to wait patiently for a few days longer, when they separated themselves from the stone, and moved about at pleasure, although they had been for some time after their birth apparently averse to motion. In the course of a few weeks about a hundred of them made their appearance on the stone. I observed that at first each of them fixed itself for a considerable time in one spot, appearing, as far as I could judge, to feed by suction; but when a ray of light from the sun was directed upon it, it seemed disturbed, and removed itself to the shaded part of the stone. Out of about a hundred insects, not above five or six were born on the south side of the stone. I examined some of them with the microscope, and observed that the smaller ones appeared to have only six legs, but the larger ones eight. It seems that they are of the genus *Acarus*, but of a species not hitherto observed. I have had three separate formations of similar insects at different times, from fresh portions of the same fluid, with

the same apparatus. As I considered the result of this experiment rather extraordinary, I made some of my friends acquainted with it, amongst whom were some highly scientific gentlemen, and they plainly perceived the insect in various states.

"*I have never ventured an opinion as to the cause of their birth*, and for a very good reason—I was unable to form one. The most simple solution of the problem which occurred to me, was, that they arose from ova deposited by insects floating in the atmosphere, and that they might possibly be hatched by the electric action. Still I could not imagine that an ovum could shoot out filaments, and that those filaments would become bristles; and moreover, I could not detect, on the closest examination, any remains of a shell. Again, we have no right to assume that electric action is necessary to vitality, until such fact shall have been most distinctly proved. I next imagined, as others have done, that they might have originated from the water, and consequently made a close examination of several hundred vessels, filled with the same water as that which held in solution the silicate of potassa, in the same room, which vessels constituted the cells of a large Voltaic battery, used without acid. In none of these vessels could I perceive the trace of an insect of that description. I likewise closely examined the crevices and most dusty parts of the room with no better success. In the course of some months, indeed, these insects so increased, that when they were strong enough to leave their moistened birth-place, they issued out in different directions, I suppose, in quest of food; but they generally huddled together under a card or piece of paper in their neighbourhood, as if to avoid light and disturbance. In the course of my experiments upon other matters, I filled a glass basin with a concentrated solution of silicate of potassa without acid, in the middle of which I placed a piece of brick, used in this neighbourhood for domestic purposes, and consisting mostly of silica. Two wires of platina connected either end of the brick with the poles of a Voltaic battery of sixty-three pairs of plates, each about two inches square. After many months' action, silica in a gelatinous state formed in some quantity round the bottom of the brick, and as the solution evaporated, I replaced it by fresh additions, so that the outside of the glass basin being constantly wet by repeated overflowings, was, of course, constantly electrified. On this outside, as well as on the edge of the fluid within, I one day perceived the well-known whitish excrescence with its projecting filaments. In the course of time they increased in number, and as they successively burst into life, the whole table on which the apparatus stood, at last was covered with similar insects, which hid themselves wherever they could find a shelter. Some of them were of different sizes, there being a considerable difference in this respect between the larger and smaller; and they were plainly perceptible to the naked eye as they nimbly crawled from one spot to another. I closely examined the table with a lens, but could perceive no such excrescence as that which marks their incipient state, on any part of it. While these effects were taking place in my electrical room, similar formations were making their appearance in another room, distant from the former. I had here placed on a table three Voltaic batteries unconnected with each other. The first consisted of twenty pairs of two-inch plates, between the poles of which I placed a glass cylinder filled with a concentrated solution of silicate of potassa, in which was suspended a piece of clay slate by two platina wires connected with either pole of the battery. A piece of paper was placed on the top of the cylinder to keep out the dust. After many months' action, gelatinous silica in various forms was electrically attracted to the slate, which it coated in rather a singular manner, unnecessary here to describe. In the course of time I observed similar insects in their incipient state forming around the edge of the fluid within the jar, which, when perfect, crawled about the inner surface of the paper with great activity. The second battery consisted of twenty pairs of cylinders, each equal to a four-inch plate. Between the poles of this I interposed a series of seven glass cylinders, filled with the following concentrated solutions:—1. Nitrate of copper: 2. Sub-carbonate of potassa: 3. Sulphate of copper: 4. Green sulphate of iron: 5. Sulphate of zinc: 6. Water acidified with a minute portion of hydrochloric acid: 7. Water poured on powdered metallic arsenic, resting on a copper cup, connected with the positive pole of the battery. All these cylinders were electrically united together by arcs of sheet copper, so that the same electric current passed through the whole of them.

"After many months' action, and consequent formation of certain crystalline matters, which it is not my object here to notice, I observed similar excrescences with those before described at the edge of the fluid in every one of the cylinders, excepting the two which contained the carbonate of potassa, and the metallic arsenic; and in due time a host of insects made their appearance. It was curious to observe the crystallised nitrate and sulphate of copper, which formed by slow evaporation at the edge of the respective solutions, dotted here and there with these hairy excrescences. At the foot of each of the cylinders I had placed a paper ticket upon the table, and on lifting them up I found a little colony of insects under each, but no appearance whatever of their having been born under their respective papers, or on any part of the table. The third battery consisted of twenty pairs of cylinders, each equal to a three-inch plate. Between the poles of this I interposed likewise a series of six glass cylinders, filled with various solutions, in only one of which I obtained the insect. This contained a concentrated solution of silicate of potassa. A bent iron wire, one-fifth of an inch in diameter, in the form of an inverted syphon, was plunged some inches into this solution, and connected it with the positive pole, whilst a small coil of fine silver wire joined it with the negative. This instrument is represented in Fig. 2.

"I have obtained the insects on a bare platina wire plunged into fluo-silicic acid, *one inch below* the surface of the fluid at the negative pole of a small battery of two-inch plates in cells filled with water. This is a somewhat singular fluid for these insects to breed in, who seem to have a flinty taste, although they are by no means confined to silicious fluids. This fluo-silicic acid was procured from London some time since, and consequently made of London water; so that the idea of their being natives of the Broomfield water is quite set aside by this result. The apparatus was arranged as follows:—Fig. 3, a glass basin (a pint one) partly filled with fluo-silicic acid to the level A. B, a small porous pan, made of the same materials as a garden pot, partly filled with the same acid to the level B, with

an earthen cover, C, placed upon it, to keep out the light, dust, &c. D, a platina wire connected with the positive pole of the battery, with the other end plunged into the acid in the pan, and twisted round a piece of common quartz; on which quartz, after many months' action, are forming singularly beautiful and perfectly-formed crystals of a transparent substance, not yet analyzed, as they are still growing. These crystals are of the modification of the cube, and are of twelve or fourteen sides. The platina wire passes under the cover of the pan. E, a platina wire connected with the negative pole of the same battery, with the other end dipping into the basin, an inch or two below the fluid; and, as well as the other, twisted round a piece of quartz. By this arrangement it is evident that the electric fluid enters the porous pan by the wire D, percolates the pan, and passes out by the wire E. It is now upwards of six or eight months (I cannot at this moment put my hand on the memorandum of the date) since this apparatus has been in action, and though I have occasionally lifted out the wires to examine them by a lens, yet it was not till the other day that I perceived any insect, and there are now three of the same insects, in their incipient state, appearing on the naked platina wire at the bottom of the quartz *in the glass basin at the negative pole.* These insects are very perceptible and may be represented thus: (magnified,) Fig. 4, A, the platina wire; B, the quartz; C, the incipient insects. It should be observed that the glass basin, Fig. 3, has always been loosely covered with paper. The incipient appearance of the insect has already been described. The filaments which project are in course of time seen to move, before the perfect insect detaches itself from its birth-place. Fig. 5, shows the insects in their various states, magnified."

FOSSIL INFUSORIA.

To the Editor.

SIR.—Having seen the accounts in various periodicals of the fossil infusoria discovered by Professor Ehrenberg, I procured some of the Berg-mehl of Sweden, and was very much delighted at viewing, under the microscope, the different shells of which it is composed. I gave a slider, containing some of it in Canada balsam, to a particular friend, who is a great lover of the microscope, and he shortly after informed me that he had seen a shell, (similar to the large kind found in the Berg-mehl,) in some water which he had taken from the spring ditch from which the town is supplied with fresh water; he followed up his investigation, and discovered two or three more of the same kind of shells. We thought at first that as the water flowed from the chalk mills in the neighbourhood, the shells were from that deposit, but further examination of the mud taken from the bottom of the ditch enabled us to find a great variety of the shells, containing the living animals, some of them being rather active, but the generality of them are sluggish and very slow in their movements.

I have at present several kinds preserved in Canada balsam, and very beautiful objects they are. If you feel interested in these minute beauties of creation, I shall feel pleasure in sending you specimens, and if you think any notice of them worthy a place in your valuable magazine, it probably may be the means of drawing more attention to these interesting little creatures, as I have no doubt but there are some species of them in every brook; although different localities may have peculiar kinds, and I sincerely wish every lover of the microscope may derive as much pleasure from their examination as I have done.

Hull, February 26, 1841. ROBERT HARRISON.

The accompanying is a sketch of some of them. A appears to be identical with one found in the Berg-mehl, but we have them alive in plenty. B, abundant. C, rather scarce. D, abundant alive. E, several. F, alive but not so plentiful as D. G, abundant, *a* as seen on its edge, *b* laid flat. H, same as in Berg-mehl. I, alive in abundance, and very active. K, very minute, and not many of them found as yet. This will, perhaps, serve to give you some idea of the kind of shells we possess.—For the figures see front page.

ON THE PROBABLE DURATION OF THE PRESENT SUPPLY OF COAL.

(Resumed from page 392, and concluded.)

PERHAPS the simplest method of discovering the respective powers of the ordinary descriptions of fuel, is by testing them with ice; thus—

1lb of good coal liquifies of ice	90 lbs.
coke	95
wood charcoal	94
wood	52
peat	19
hydrogen gas	320

The qualities of coal depend upon its proportions of the common components carbon, hydrogen, and earthy impurities totally incombustible. While some kinds of coal contain nearly one-third of their weight of hydrogen, others do not possess a fiftieth; but almost every quality is more or less valuable for some among the many purposes to which it is now applicable. The kinds of coal containing the greatest proportion of hydrogen, are those most preferred for fuel in private houses, since they burn with a bright and cheerful flame. Some of the Welsh and Scotch coal will only burn when in large heaps, or mixed with more inflammable coal; their proportion of hydrogen being so small that they are consumed almost without flame; hence the term *blind*, as applied to some of the Scotch coal. When flaming coal is burned where a sufficiency of oxygen cannot pass through, or enter above the fire, to combine with and consume the hydrogen as fast as it rises, a dense smoke is given out, consisting of hydrogen and carbon. The property of emitting little smoke gives value to the Welsh coal for the use of breweries and manufactories in crowded districts, where smoke would be a nuisance.

Although London now derives a partial supply of coal from other sources, the principal demand is still made upon the great northern stores, and it is highly probable that as railroads multiply, this demand will be increased. But, besides these valuable and extensive strata, Cumberland abounds with coal; it is also extensively wrought in Staffordshire, Derbyshire, Lancashire, Yorkshire, Leicestershire, Warwickshire, South Wales, &c.; and in Scotland it is found in the Lothians, Lanarkshire, Renfrewshire, Ayrshire, and other counties; but in Ireland, it is both deficient in quantity and inferior in quality to that of Great Britain.

When it is remembered that a number of people, to an amount approaching 200,000, are employed in this trade, and that this trade in so many of its

bearings contributes so much to the prosperity of this country, it cannot but present a subject of intense interest to every one of its reflecting inhabitants. From the evidence of Mr. Buddle, of Wallsend, offered to a committee of the House of Lords, we make the following extract, which shows the number of persons employed in the northern coal district.

"I hold a paper in my hand stating the number of people employed in the coal trade in each department. I would beg to observe that the returns from the Tyne are official documents; from the Wear I have no returns, but it is by an approximate calculation. The number of persons employed underground on the Tyne is, men, 4,937; boys, 3,554; together, 8,491: above ground, men, 2,745; boys, 718; total, 3,463: making the total employed in and about the mines 11,954, which in round numbers I call 12,000, because I am very sure that there were some omissions in the returns. On the river Wear I conceive that there are 9,000 employed; making 21,000 employed in digging the coal, and delivering it to the ships on the two rivers. From the best calculations that I have been able to make, it would appear that, averaging the coasting vessels that carry coals at the size of 220 London chaldrons each vessel, there would be 1,400 vessels, which would require 15,000 seamen and boys. I have made a summary. There are, seamen, 15,000; pitmen, and above ground people employed at the collieries, 21,000; keelmen, coal boatmen, casters and trimmers, 2,000; making the total number employed in what I call the northern coal trade, 38,000. In London, whippers, lightermen, &c., 5,000; factors, agents, &c., on the Coal Exchange, 2,500; being 7,500 in London—in all, making the grand total in the north country and London departments of the trade, 45,500. This, of course, does not include the persons employed at the outports in discharging the ships there."

We have no means of arriving at anything like an exact estimate of the number of persons employed in the other branches of the coal trade, but if we consider the above proportions with regard to the probable estimate of the entire consumption, the total must fall somewhere between 150,000 and 180,000.

Regarding the probable duration of the current supply, a report was some years ago laid before a committee of the House of Lords by Mr. Taylor, already mentioned. It is therein stated that the coal fields of Durham and Northumberland have consisted of 837 square miles, 105 of which have been worked, leaving yet available, in this district alone, 732 square miles. This gentleman estimates the workable coal strata at an average thickness of twelve feet, according to which calculation the contents of one square mile will be 12,390,000 tons, and of 732 square miles, 9,069,480,000 tons. For small coal, under ground casualties, such as dykes, &c., deduct one-third—

9,069,480,000
3,023,160,000

6,046,320,000

and this remainder, continues the same report "is adequate to supply the current annual draught from Newcastle, Sunderland, Blyth, Stockton, &c. of 3,500,000 tons for a period of 1,727 years.' With respect to Wales, the stores of coal and ironstone deposited there are as yet unopened. It has been stated that the Welsh coal-fields extend over 1,200 square miles, and that there are 23 beds of workable coal, having an average thickness of 55 feet. Each acre will yield 100,000 tons, being at the rate of 65,000,000 tons per square-mile. If from this we deduct one-half for waste, and the minor extent of the upper beds, this will afford a supply of coal equal to 32,000,000 tons per square mile. Let it be conceded that 5,000,000 equal one-third of the total consumption in England, and each square mile of the Welsh coal field will meet a proportionable consumption, of a hundred years; and as there are from 1,000 to 1,200 square miles in this coal district, it would supply England with coal for 2,000 years after all our English coal-mines were exhausted. It is, therefore, absurd to ground restriction to this trade on the plea of an apprehended exhaustion of the supply.

Much of the high price of fuel in London is commonly, but erroneously, attributed to what is called the northern "coal monopoly," although for exclusive dealing in coal there is neither law nor reason, and this high price will, upon inquiry, be found to be an accumulation of imposts. Instead of the business of coal-mining being, generally speaking, an advantageous one, it is distinctly the reverse. Sometimes, indeed, large fortunes, under certain circumstances, have been realized by individuals and companies, but these are rare instances. The opening of a mine is a most expensive and hazardous undertaking, and one even of uncertain results, for collieries are exposed to accidents against which no caution can avail. The chances of explosion are now, it is true, diminished, since the introduction of Sir H. Davy's lamp, but for which many workings must have been abandoned; but explosions are not the only dangers to be apprehended, for mines are liable to be destroyed by inundations from old workings—irruptions of water through fissures which cannot be guarded against, because they are rarely to be discovered. In Mr. Buddle's first report to the House of Lords, to the question, "What have the coal-owners on the Tyne and Wear generally made on the capital employed?" he replied, "By no means ten per cent. at simple interest, without allowing any extra interest for the redemption of capital."

VARNISH.

(Omitted in previous Papers.)

The varnish of Watin, for gilded articles.—Gum lac, in grain, 125 parts; gamboge, 125; dragon's blood, 125; annotto, 125; saffron, 32. Each resin must be dissolved in 1000 parts by measure, of alcohol of 90 per cent.; two separate tinctures must be made with the dragon's blood and annotto, in 1000 parts of such alcohol; and a proper proportion of each should be added to the varnish, according to the shade of golden color wanted.

For fixing engravings or lithographs upon wood, a varnish called *mordant* is used in France, which differs from others chiefly in containing more Venice turpentine, to make it sticky; it consists of sandarach, 250 parts; mastic in tears, 64; rosin, 125; Venice turpentine, 250; alcohol, 1000 parts by measure.

Milk of wax, is a valuable varnish, which may be prepared as follows:—Melt in a porcelain capsule a certain quantity of white wax, and add to it, while in fusion, an equal quantity of spirit of wine, of sp. gr. 0·830; stir the mixture, and pour it upon a large porphyry slab. The granular mass is to be converted into a paste by the muller, with the addition, from time to time of a little alcohol; and

as soon as it appears to be smooth and homogeneous, water is to be introduced in small quantities successively, to the amount of four times the weight of the wax. This emulsion is to be then passed through canvas, in order to separate such particles as may be imperfectly incorporated.

The *milk of wax*, thus prepared, may be spread with a smooth brush upon the surface of a painting, allowed to dry, and then fused by passing a hot iron (salamander) over its surface. When cold, it is to be rubbed with a linen cloth to bring out the lustre. It is to the unchangeable quality of an encaustic of this nature, that the ancient paintings upon the walls of Herculaneum and Pompeii owe their freshness at the present day.

Black japan, is made by putting into the set-pot 48 pounds of Naples, or any other of the foreign asphaltums, (except the Egyptian.) As soon as it is melted, pour in 10 gallons of raw linseed oil; keep a moderate fire, and fuse 8 pounds of dark gum animé in the gum-pot; mix it with 2 gallons of hot oil, and pour it into the set-pot. Afterwards fuse 10 pounds of dark or sea amber in the 10 gallon iron pot; keep stirring it while fusing; and whenever it appears to be overheated, and rising too high in the pot, lift it from the fire for a few minutes. When it appears completely fused, mix in 2 gallons of hot oil, and pour the mixture into the set-pot; continue the boiling for 3 hours longer, and during that time introduce the same quantity of driers as before directed: draw out the fire, and let it remain until morning; then boil it until it rolls hard, as before directed: leave it to cool, and afterwards mix with turpentine.

Best Brunswick Black.—In an iron pot, over a slow fire, boil 45 pounds of foreign asphaltum, for at least 6 hours; and during the same time boil in another iron pot 6 gallons of oil which has been previously boiled. During the boiling of the 6 gallons, introduce 6 pounds of litharge gradually, and boil until it feels stringy between the fingers; then ladle or pour it into the pot containing the boiling asphaltum. Let the mixture boil until, upon trial, it will roll into hard pills; then let it cool, and mix it with 25 gallons of turpentine, or until it is of a proper consistence.

Iron-work Black.—Put 48 pounds of foreign asphaltum into an iron pot, and boil for 4 hours. During the first 2 hours, introduce 7 pounds of litharge, 3 pounds of dried copperas, and 10 gallons of boiled oil; add 1 eight-pound run of dark gum, with 2 gallons of hot oil. After pouring the oil and gum, continue the boiling 2 hours, or until it will roll into hard pills like japan. When cool, thin it off with 30 gallons of turpentine, or until it is of a proper consistence. This varnish is intended for blacking the iron-work of coaches and other carriages, &c.

A Cheap Brunswick Black.—Put 28 pounds of common black pitch, and 28 pounds of common asphaltum made from gas tar, into an iron pot; boil both for 8 or 10 hours, which will evaporate the gas and moisture; let it stand all night, and early next morning, as soon as it boils, put in 8 gallons of boiled oil; then introduce, gradually, 10 pounds of red lead, and 10 pounds of litharge, and boil for 3 hours, or until it will roll very hard. When ready for mixing, introduce 20 gallons of turpentine, or more, until of a proper consistence. This is intended for engineers, founders, ironmongers, &c.; it will dry in half an hour, or less, if properly boiled.

Axioms observed in the Making of Copal Varnishes.—The more minutely the gum is run, or fused, the greater the quantity, and the stronger the produce. The more regular and longer the boiling of the oil and gum together is continued, the more fluid or free the varnish will extend on whatever it is applied to. When the mixture of oil and gum is too suddenly brought to string by too strong a heat, the varnish requires more than its just proportion of turpentine to thin it, whereby its oily and gummy quality is reduced, which renders it less durable; neither will it flow so well in laying on. The greater proportion of oil there is used in varnishes, the less they are liable to crack, because the tougher and softer they are. By increasing the proportion of gum in varnishes, the thicker will be the stratum, the firmer they will set solid, and the quicker they will dry. When varnishes are quite new made, and must be sent out for use before they are of sufficient age, they must always be left thicker than if they were to be kept the proper time. Varnish made from African copal alone possesses the most elasticity and transparency. Too much driers in varnish render it opaque and unfit for delicate colors. Copperas does not combine with varnish, but only hardens it. Sugar of lead does not combine with varnish. Turpentine improves by age; and varnish by being kept in a warm place. All copal or oil varnishes require age before they are used.

Concluding Observations.—All body varnishes are intended and ought to have 1½ lbs. of gum to each gallon of varnish, when the varnish is strained off, and cold; but as the thinning up, or quantity of turpentine required to bring it to its proper consistence, depends very much upon the degree of boiling the varnish has undergone, therefore, when the gum and oil are very strongly boiled together, a pot of 20 gallons will require perhaps 3 gallons above the regular proportionate quantity; and if mixing the turpentine is commenced too soon, and the pot not sufficiently cool, there will be frequently above a gallon and a half of turpentine lost by evaporation.

All carriage, wainscot, and mahogany varnish ought to have fully 1 pound of gum for each gallon, when strained and cold; and should one pot require more than its proportion of turpentine, the following pot can easily be left not quite strongly boiled; then it will require less turpentine to thin it up.

Gold sizes, whether pale or dark, ought to have fully half a pound of good gum copal to each gallon, when it is finished; and the best black japan, to have half a pound of good gum, or upwards, besides the quantity of asphaltum.

FIREWORKS.

(Resumed from page 234, and concluded.)

Gerbes.—This is a species of firework which, from a cylindrical case, throws up a luminous and sparkling jet of fire, which from its partial resemblance of a water-spout, the French have given the appellation of gerbe.

Gerbes consist of a strong cylindrical case, made of thick paper or paste-board, and filled with brilliant composition, and sometimes with stars or balls placed at small distances, so that the composition and balls are introduced alternately; immediately below each ball is placed a little grained powder. This last kind of gerbes are more properly called Roman candles. Gerbes are sometimes made wholly cylindrical, and sometimes with a long

narrow neck; the reasons for making them with a neck are deduced from rather philosophical considerations: when fired they exert great force on all parts of the case, especially at the mouth, from which it proceeds with great velocity; the reasons therefore deduced for making them with a long neck are—first, that the particles of iron, which enter into their composition, will have more time to be heated, by meeting with greater resistance in getting out than with a short neck, which would be burnt too wide before the charge be consumed, and spoil the effect; secondly, that with long necks the stars will be thrown to a greater height, and will not fall before they are spent or spread too much; but when made to perfection, will rise and spread in such a manner as to represent pretty exactly the form of a wheat-sheaf.

The diameter of gerbes is generally estimated by the weight of a leaden ball, which the case is capable of receiving; thus we say, gerbes of eight ounces, of one pound, &c. Their length from the bottom to the top of the neck should be about six diameters, the neck being about one-sixth diameter, and three-fourths diameter long. They are filled in two ways, according as they have a neck, or are wholly cylindrical; the cases of the latter kind are closed below, and are filled like those of serpents, but the composition must be put in by small quantities, and rammed very hard; cases with necks are filled from the bottom, but you must be careful, before you commence ramming, to plug up the aperture of the neck with a piece of wood fitted to its diameter, for if this is not done, the composition will fall into the neck, and leave a vacancy in the case, which will cause it to burst as soon as the fire arrives at that part of it.

You must observe too, that the first ramming or two be of some weaker composition than the body of the case. When filled the plug must be removed, and the neck filled with some slow charge, and capped with touch paper; a foot of wood is afterwards to be fixed to the gerbe and well secured, either by a cylinder fixed to the outside of the case, or by having in it a hole, into which the case may be inserted; when either of these methods is employed, the foot must be firmly attached.

Sometimes sparks are introduced during the filling of the cases, but in this case special care must be taken that they are not broken by hard ramming; their number should be regulated by the size of the case, and when carefully used, they produce a pleasing effect, but they are most adapted to such gerbes as are wholly cylindrical.

The following method of finding the interior diameter of gerbes is generally employed: supposing the exterior diameter of the case at bottom, which is usually made somewhat larger than the top, to be four inches, then by taking two-fourths for the sides of the case, there will remain two inches for the bore, which will be a tolerable good size, and from the rules given for the height the same will be about 24 inches to the top of the neck.

In ramming large gerbes an external mould will not be requisite, the cases being sufficiently strong to support themselves.

Small Gerbes.—These are frequently called white fountains; they differ but little, when used as gerbes, from the foregoing; they are made of four, eight, or twelve ounce cases, of any length, pasted and made very strong; before they are filled, drive in about one diameter of their orifice high some good stiff clay, and when the case is filled, bore through the centre of the clay to the composition a vent-hole of common proportion, which must be primed and capped as before.

These cases are sometimes filled with Chinese fire; in this case the clay must not be used, but filled the same as cylindrical cases, and footed and primed in the same manner. The composition fit for them is meal-powder, 1½ lb.; iron sand, 5 ozs.

Roman Candles.—Roman candles are constructed nearly after the manner of gerbes; their cases are made perfectly cylindrical, as above described, and between the layers of composition, are interposed balls, or stars, which are prepared as directed for rockets, but larger and rolled round by the fingers. In filling and ramming Roman candles, especial care must be taken that the stars are not broken in the operation. When the cases have been properly rolled and dried, and their bottoms firmly secured by tying them with some strong twine, it is best, previous to putting in the composition, to ram a little dry clay, which will fill up the hollow, and leave a better bottom to the case. This being properly done, put in a small quantity of corn powder, and over this a small piece of paper, just to prevent the composition from mixing with the powder; then as much of the composition is to be put in as will, when rammed hard down, fill the case about one-sixth of its height; then over this a small piece of paper, (covering about two-thirds of the diameter,) as before, then a little corn powder, and upon that a ball is to be placed, observing to let the ball be somewhat less than the diameter of the case. Over this first ball more of the composition is to be introduced, and pressed lightly down, till the case is about one-third full, when it may be rammed, but with some gentle strokes, lest the ball is broken by it; then a piece of paper, a little corn powder, and upon it another ball, as before; so that the case after this manner will contain five or six balls with regular beds of composition between them, and have about the same length of composition above the highest ball. When the case is thus filled, it is to be capped with touch-paper by pasting it round the orifice, and a little priming of mealed powder being added, the piece is rendered complete.

In regard to the stars or balls, it is best that their form be flat and circular, or even square, rather than spherical, as they will be less liable to be injured in the filling; they should also be somewhat different in size, which is found to add much to their effect; that is, let the first star be about two-thirds the diameter of the case, let the next be a little larger, and so on increasing to the fourth, fifth, or sixth, which last should fit tight into the case.

Observe also to let the quantity of powder at the bottom of each ball increase as the balls increase in diameter, or as they come nearer the top of the case; not on account of the additional weight of the ball, but, as on those balls situate near the top, the force of the powder ceases to act on the ball, sooner than on those situate lower in the case, consequently the force to throw the ball to the same distance must increase proportionably; another reason for decreasing the quantity of powder towards the bottom is, that the same quantity used with the bottom as with the top ball, would cause the case to burst, and destroy all the effect which they are intended to produce.

The composition for filling is, mealed powder half a pound, saltpetre two pounds and a half, sulphur half a pound, glass dust half a pound.

Pots des Brins.—These are large paper cylinders, filled with powder, stars, sparks, &c. They are generally made of paste-board, and about four diameters long; they should be choaked at one end like common cases. They are generally exhibited in numbers, fixed on a plank of some kind, in the following manner: on the under side of your plank, make as many grooves as you intend to have rows of pots, then at a little distance from each other, and exactly over the grooves, fix as many pegs, about three-fourths of one diameter high; then through the centre of each peg bore a hole down to the groove at bottom, and on every peg fix and glue a pot, the mouth of which must fit tight on the peg; then through all the holes run a quick-match, one end of which must go into the pot, and the other into the groove, which must have a match laid in it from end to end, and covered with paper, so that when lighted at one end it may discharge the whole instantaneously. In each pot put about one ounce of mealed and corn powder; then put in some stars, and in others rain, snakes, serpents, crackers, sparks, &c. When they are loaded, secure their mouths by putting paper over each.

When fired in considerable numbers, these pots des brins, from their affording so great a variety of fires, produce a most pleasing exhibition.

Chinese Fountain.—Provide a piece of dry wood, about six or seven feet long, and about two and a half inches square; at the distance of sixteen inches from the top of this piece, (supposing it be seven feet long, and fixed perpendicular,) must be fixed a shelf, sixteen inches long, and in width about two and a half inches, and in thickness about three-quarters. Below this shelf must be fixed three or four other shelves of the same width and thickness, but in length increasing eight inches successively as they go towards the bottom. They must be fixed the same distance from each other as the first one from the top.

Now on the top of the post, insert (into a hole of proper dimensions) a gerbe, or fire-pump; on the first shelf insert after the same manner two gerbes, on the second three, on the third four, on the fourth five, and on the bottom shelf six; they must be so placed, that the next above stand exactly over the intervals of those below. The gerbes should be placed so that their mouths incline a little forwards; if this be not done, the stars thrown out of the cases will strike against the shelf above, and produce but little of that effect, which, when properly arranged, renders them so beautiful.

A proper connection must be formed with your leaders, between the different cases; beginning at the top, and carrying it downward to every one of them. The top one is to be lighted first.

Pyramids of Flowerpots, or of Mines.— In general construction, this article is exactly similar to the one just described; but in place of gerbes, or fire-pumps, it is loaded with mortars, filled with serpents, crackers, &c. and having in the centre of each a case filled with spur-fire. The mortars should be made of paste-board, wound two or three times round a cylinder, about four inches diameter, and well secured by glue, by which means their bottoms and tops are fixed to them.

The spur-fire, which is the chief ornament of these pieces, is prepared as follows:—It has been said that excellence can never be obtained, without overcoming commensurate difficulties: this is certainly verified in the preparation of this composition; for nothing can exceed the difficulty and trouble in preparing it, and nothing can exceed the beauty of its appearance *when properly prepared.* It is said to be the invention of the Chinese, and is certainly the most beautiful and curious of any yet known.

The principal care in the preparation, is, to have the ingredients of the very best quality; next to that is the well grinding and mixing them together.

The proportion of the ingredients is saltpetre four pounds and a half, sulphur two pounds, and lamp-black one pound eight ounces. One great difficulty is in the mixing these ingredients together; it is best to sift the saltpetre and sulphur together first, and then put them into a marble mortar, and the lamp-black with them, which must be worked down by degrees with a wooden pestle till all the ingredients appear of one color, which will be somewhat grayish, but more inclined to black; when this is done drive a little into a case for trial, and fire it in a dark place; if sparks come out in the form of *stars* or *pinks*, and in clusters, spreading well without any other sparks, it may be considered good: if it appear drossy, and the stars not full, it is not mixed enough; but if the pinks are very small, and soon break, it is indicative of an excess of rubbing; if the excess is great, it will be too fierce, and hardly show any stars: on the other hand, if the rubbing or mixture is in defect, it will be too weak, and produce nothing but an obscure or black smoke.

This composition is generally rammed in one or two ounce cases, about five or six inches long; care must be taken not to ram it too hard. The aperture at the choak should not be so wide as is usually given to other choaked cases.

It is somewhat remarkable, that the composition should be improved by being kept in the cases; but it is found that they always play better, if suffered to stand a time after they are filled.

In preparing the pyramid of flower pots, the cases of spur-fire are to be placed in the middle of the mortars, and be connected by leaders, so that they may all be fired together. The cases will first play off in a very pretty manner; and when exhausted, the fire from them communicates to the powder at the bottom of the mortars, and this suddenly taking fire, all blow up simultaneously, and scatter their luminous fragments in the air: the serpents hiss, the crackers bounce, and the illuminated stars fly in all directions, producing considerable amusement and surprise, and forming an excellent conclusion to a small exhibition.

This beautiful composition is also susceptible of other representations, many of which may, without the least danger, be exhibited within a room, as well as in the open air; it is really of so innocent a nature, that it may be (though improperly) called a *cold fire;* for it is found that when well made, the sparks will not burn a handkerchief when held in the midst of them; they may be held in the hand with perfect safety; if the sparks fall a short distance upon the hand, you feel them like drops of rain.

A pretty exhibition may be produced by placing a number of spur-fires round a transparent pyramid of paper, and fired in a room, or in the open air. In all cases, and in every variety of exhibition, this fire is very beautiful, and will always repay the labour of preparation.

Fig. 1.

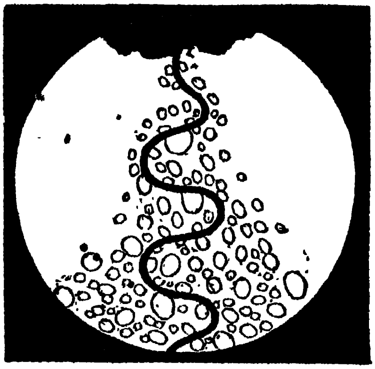


Fig. 2.

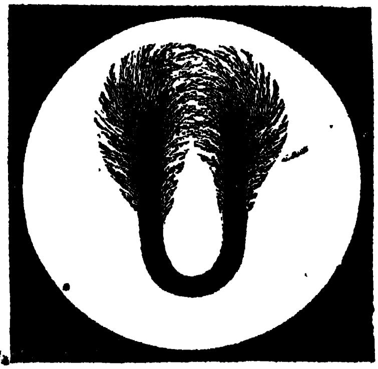


Fig. 3.

OBJECTS FOR THE OXY-HYDROGEN MICROSCOPE.

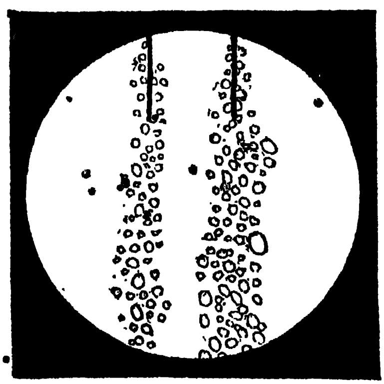


Fig. 4.

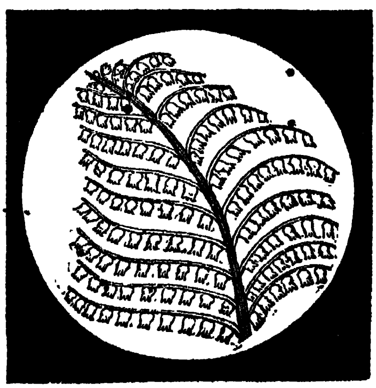


Fig. 5.

OBJECTS FOR THE OXY-HYDROGEN MICROSCOPE.

(Resumed from page 331.)

We are very anxious to complete, as far as possible, in the present volume, all our continued articles; with which view, we give another paper on the objects adapted to the gas microscope. This will perfect that portion of the subject, except as relates to living objects, which may well form a paper on a future occasion. At present, we have to present to our readers' notice a series of objects of a peculiar character, and such as are not adapted to table microscopes. They were all first suggested by Mr. E. Clarke, for public exhibition at the Adelaide Gallery, and other Institutions of London, and we therefore cannot do better than give them in Mr. Clarke's own words, as follows:—

"Fig. 1, exhibits a beautiful illustration of the magnetic currents obtained by placing a small horse-shoe magnet between the glasses of the slider, and allowing very fine iron filings to fall within its sphere of attraction.

"These filings are not seen falling, but the instant they adhere they become visible and appear to start into existence, branching out as they increase, into elegant curves, presenting the appearance of an extraordinary instantaneous vegetation. These, when seen expanding rapidly over a disc of twenty feet in diameter, have more the aspect of magic than anything natural. They seem to spread like the branches and leaves of a tree, bursting into its fulness of growth in seconds, instead of seasons. Then, if the slider be tapped with the fingers, (or better, with a key) the branches will be seen to move and alter, arranging themselves, here more compactly, and there more loosely, growing closer in some places and leaving intervals in others, like foliage waving in the wind.

"The decomposition of water by chemical action presents a very curious appearance under the gas microscope. This exhibition is effected by the adaptation of a glass trough to the microscope, (to be introduced horizontally in the manner of a slider,) containing dilute sulphuric acid, (similar to that employed in the preparation of hydrogen gas,) and dropping into it a few pieces of fresh broken zinc. Decomposition of the water instantly commences. Its oxygen gas combines unperceived with the zinc, which then dissolves gradually in the sulphuric acid; while the hydrogen gas set free at the same instant, rapidly rises in bubbles through the liquid, and escapes at the surface. These bubbles, magnified, present a most extraordinary appearance, forming a series of whitish luminous globules descending in the fluid (for everything appears reversed in the microscopic exhibitions,) from an opaque surface, and swelling enormously as they struggle to the surface under the trebly expansive powers of heat, combination, and lessening pressure.

"The troughs in which this chemical preparation was made, were formed (at the time I first turned my attention to the subject) of two slips of window glass, joined with glaziers' putty, and held together by a tin or brass frame at the ends. The putty often gave way under the effect of the violent action going on within, and the acid solution oozed out, to the great injury of all the parts of the microscope with which it came in contact. This very defective construction I remedied at once, by causing glass troughs to be made without joinings, in moulds, and afterwards ground and polished, so that exhibitions of the beautiful luminous bubbles of hydrogen can now take place without any inconvenience to the operator, or injury to the apparatus.

"These troughs also enabled me to adapt, with fine effect, Sturgeon's interesting experiment of the decomposition of water, by a voltaic circuit, arising from the action of platina on amalgamated zinc, in the following manner:—The trough containing dilute sulphuric acid, as in the previous exhibition, is introduced horizontally, and held fast in its place, like a slider, by the internal spring. A piece of amalgamated zinc is then dropped into the liquid, but no action takes place. A piece of platina wire is then thrust into the liquid, but if kept apart from the amalgamated zinc, still no action is apparent. The moment, however, that the wire is brought into contact with the amalgamated lump, pearly bubbles of gas are seen to form on all parts of the platina. Here the lump of amalgamated zinc is seen in dark profile on the illuminated disc, and the equally dark serpentine line in contact with it, is the platina wire, Fig. 2. It will be observed, that notwithstanding the platina wire is covered with gas, not a single bubble is given off from the amalgam. If the wire is lifted from its contact with the latter, all chemical action and formation of bubbles instantly cease. If again allowed to touch the amalgamated zinc, the gas is generated, as at first.

"A subsequent step in the progress of invention, was the construction of a glass trough for exhibiting, in the gas microscope, the decomposition of water by magnetic electricity. This I accomplished, by inserting two pieces of platina wire separately through the bottom of the glass trough, at a distance of one-sixteenth of an inch, and projecting upwards about three quarters of an inch. The external ends of these platina wires were dipped into cups of mercury, so as to allow of their continued connection and adjustment with the gas microscope, and my magnetic electrical machine. (A description of this apparatus, and directions for its use, has appeared in a previous number.—*Ed.*) Into this trough, dilute sulphuric acid was poured as usual; a connexion was then made with the magnetic electrical apparatus, the decomposition of the water instantly commenced at the two platina poles, and the gaseous result was beautifully depicted (in reverse) on the illuminated disc, as in Fig. 4, the two fine platina wires appearing like large posts: one yielding a copious stream of hydrogen bubbles, the other giving off only half the quantity of oxygen gas.

"A beautiful series of objects is produced by the rapid evaporation of saline solutions, and the evolution of their crystals under the low power of the microscope. To exhibit these effects in the most striking manner, take up a large drop of the concentrated solution (suppose of muriate of ammonia, commonly called sal ammoniac,) with a hair-pencil, and place it on the end of a single glass slider, in quantity just sufficient to run down slowly when that end is elevated, and the plate introduced vertically into its place in the microscope. This must be done quickly, that all the interesting changes resulting from the evaporation of the water of solution may be depicted on the illuminated disc. This evaporation takes place with augmenting rapidity, under the heat imparted by the combustion of the gases, and will produce the desired crystallization soonest, if in the first instance restricted to the spot on which the drop was placed, and from which it has been allowed to slide, leaving the place

slightly wetted. The appearance of the crystals as the moisture dissipates, is beautifully striking. First, one will dart from the edge of the liquid towards the centre in the form of a spear. Others dart into existence parallel to it, and lengthen on in rows till stopped by one which shoots like an arrow across its path at an angle of forty-five degrees. A flight of arrows will then, perhaps, accompany the latter, to be stopped in their course by the formation of other crystals driving in another direction under the powerful desiccating influence of the lime-light, (or rather lime-heat,) although light has also a considerable stimulating influence on crystallization: reminding the spectator of *chevaux de frise*, groups of muskets, bayonets, swords, and spears, in an armoury, and the beautiful arrangements which the fibres of feathers sometimes present. When all the crystals have formed in one spot, and the solution dried up, by raising the slider you may renew the scene, until all the salt contained in the original drop has formed itself into crystals, under the laws of aggregation which govern it—presenting in the midst of apparent confusion perfect mathematical order and regularity; so that a scientific eye can at once predicate the constitution of the crystal, either as to purity or admixture with other elements, according to the peculiarity of form assumed by the crystalline body under the circumstances. The salts of Epsom, Rochelle, and Cheltenham, the sulphates of soda and copper, the bichromate of potash, and numerous others, show interesting varieties of formation. The exhibition of the most striking, would form a valuable series of illustrations for a lecture on crystallography, interesting alike to the mathematician, the chemist, and the physician.

"While speaking of the effects of the low magnifying power, I may mention a class of artificial objects which afford very pleasing effects. These consist of transparent *cameos* and *intaglios*, cut in slight relief. The latter produce the best pictures on the disc, but great care is required in their preparation, or rather in their selection; for if the proportion between the surface and the heights, or depths, be great or abrupt, it will be impossible to transmit a good representation, in consequence of the difficulty of accommodating the focal distance to both classes of inequalities at the same time. Where the convexities and concavities are found in harmonious proportions, the pictorial effects are very fine, presenting a mellow semi-transparency that passes by insensible degrees from lights into shades, approaching more closely to those obtained by the dioramic porcelain tableaux than to any other, but in a style peculiarly unique, resulting from the greater freedom of refraction as well as transmission. It seems as if the figure were raised in basso-relievo stucco work, softly lighted up, on the disc, Fig. 3.

"Before removing the low magnifying power, it will be instructive to examine, by its aid, the various works of art which pass in ordinary before our eyes, as peculiarly fine and delicately executed. A piece of the finest cambric thus magnified, presents an apparition of a fabric, which recalls to our memory Gulliver's description of his clothing in Brobdignag. An exquisite piece of Brussels or Honiton lace undergoes a similar burlesque metamorphosis into coarse netting. The edge of a razor resembles a saw; the points of needles and lancets exhibit rugged sinuosities and rough excrescences; and a full stop, which in ordinary punctuation strikes an eye as circular, appears with an outline full of gaps and irregularities, and probably as gibbous as the moon in the third quarter.

"Both the mineral and animal kingdoms furnish some beautiful contrasts to the imperfections of art, in the finish and polish of their points and surfaces. The majority of crystals and precious stones furnish exquisite instances of smoothness; and the forceps and sting of the wasp, supply convincing instances of the perfection of sharpness to which animal organization can attain.

"Fig. 5, presents us with a very distinct view of the curious and beautiful structure observed in a species of zoophyte, named *sertularia*, in which the cells appear like *campanulæ*, or little bell-flowers."

ARTIFICIAL PROCESS OF PETRIFACTION.

BY M. GÖPPERT.

The idea of petrifaction belongs to a comparatively small number of the impressions of wood and stems which we find in all formations, and still more abundantly in boulders at a distance from their original locality, and the term ought always to be so limited.

The vegetation preserved in brown coal often hardly deserves any other term than that of dried vegetable matter; and, in fact, fossil wood often differs but little externally from wood which has lain for a long period in water.

The phenomenon of petrifaction was attempted to be explained at an early period. Agricola thought that it took place by means of a liquid containing stony matter, which penetrated the spaces of vegetable and animal bodies, and gradually communicated to them a stony character. The later mineralogists, as Scheuchzer, Walch, Schulze, Schröter, Wallerius the elder, agreed in the opinion, that, when a body is petrified, or converted into metal, an exhalation must proceed from it, whereby it loses certain particles, in whose room earthy or metallic ones enter, and that thus, at last, the body is converted into stone or metal. The means by which the exhalation is promoted in animals is, according to the same view, calcination, and in plants the reduction to earth. More recently, so far as is known to me, no one has attempted to trace out this process by an experimental inquiry, it being probably supposed that too long a time would be required for obtaining the desired result. In a lecture delivered in London by Faraday, at the beginning of 1836, he says, "that we have no knowledge whatever of the nature of this process, for the instances of recent fossilization, which have as yet been produced from various places, are mere incrustations of calcareous, or even of siliceous matter, where there has been no preservation of organic forms—none of that beautiful and incomprehensible *substitution* which, while it excites our admiration, baffles our curiosity." For a long time I was occupied in examining the way which nature had employed in this process. First of all I made the experiment with iron. I introduced plants into a moderately-concentrated solution of sulphate of iron, and left them there until the separation of the salt on the outer portions of the plants showed the sufficient saturation, or I at once soaked smaller portions of plants and sections of wood in the same solution for several days. They were then dried and heated till they no longer suffered alteration of volume, or until every trace of organic matter had disappeared. On cooling

them, I found the oxide thus produced in the form of the plant. I now took thin vertical sections of the Pinus sylvestris, treated them in the same manner, and found them so well preserved after heating that the punctured vessels peculiar to this family were still perceptible. Just as well preserved were the sporangia of ferns: the pollen (of Arum Dracunculus, Ricinus communis, &c.;) mosses (Hypnum splendens, intricatum, Fontinalis squamosa;) and even fungi, as Agaricus deliciosus, Clavaria flava, &c. After these successful experiments, I was desirous to perform others with a solvent of silica. In vain I tried the common solution of silica. For when, after heating, the silica remained in the form of the plants, the mass, as was easily understood, disappeared on being cooled. I obtained a more successful result by dipping in a volatile acid such as the acetic, and before the application of heat, the fragment that had been soaked in a siliceous solution; but still a portion of the silicia taken up by the plants was separated, and so irregularly that it became impossible to recognise the structure. Silico-hydro-fluoric acid, prepared according to the formula of Berzelius, answered my wishes better, for the fluoric acid was volatilized, and the silica remained in the form of the plant. Similar results were obtained with most of the other earths and metals, and I generally selected combinations whose acids were easily decomposed by heat, as acetate of lime, acetate of magnesia, sulphate of magnesia, which were all converted into carbonates; nitrate of silver, nitrates of gold and platina, which were all converted into reguline metals; acetate of copper, which was converted into brown oxide; acetate of nickel and bichromate of potash into olive-green oxides; acetate of lead into yellow oxide; manganese into metallic shining manganese; cobalt, wolfram, and molybdena into oxides; and all of them retaining more or less the vegetable structure. In proportion as the number of vessels in a plant is greater, and therefore the quantity of cellular tissue less, so much the more perfect are the results obtained in these experiments. In very delicate portions an immersion for a few days is sufficient, and in larger pieces a longer period is requisite.

In order to ascertain the change undergone by the organs of the plants, I placed the above-mentioned products in water. The potash skeleton, which may be distinctly seen in most plants, is dissolved, and I thought at first that I remarked that only the vessels were filled or injected with metallic or earthy matter, and that their sides were destroyed by the action of the fire. When, however, I experimented in the same way on several plants which contained less alkali, I saw, in company with my much-respected friend Professor Purkinje, that, for example, by immersing in an iron solution the wing-like appendages of the seeds of the Pinus sylvestris, the walls of their peculiar fibre-like formed cells were actually converted into iron; and that, in the case of a vertical section of the Pinus sylvestris, which was soaked in silico-hydro-fluoric acid, the punctured vessels were converted into silica. In those which are changed into reguline metal, we see this phenomena very distinctly if we continue the red heat for only half an hour. By a longer continued action of this degree of heat, the arrangement of the metal is so altered that the connexion of the vessels and cellular tissue is somewhat broken; and now (I cannot suppress the remark, although I do not draw any conclusion from it,) there is a great resemblance to those hair-like forms in which the above-mentioned metals sometimes occur in the native condition. The richer a plant is in potash and cellular tissue, a condition which occurs in herbaceous plants, the less do these experiments succeed. It is true, that after the heating there appears in the form of the plant the earth or the metal which has been employed, but, on pouring water over it, nearly everything is dissolved, and only separate vessels or cells remain behind; as, for example we remark, in the leaves of the ferns. Although these experiments which also promise much advantage to vegetable physiology, are capable of being carried much farther, yet, when we apply their results, first of all, to the process of petrifaction we can already understand why only trees and shrubs occur truly petrified, and never herbaceous plants. Shrubs occur more rarely than trees, because, though they contain less potash than herbaceous plants, yet when calcined they yield more than trees. If we proceed in this way, we shall in future possess in chemistry an important and serviceable assistance for the determination of fossil plants, as we shall be authorised, by the experiments detailed above, to declare, with certainty, that plants rich in potash can never be petrified: an assumption we are so much the more entitled to adopt, since the experiment with the fossil fern proves, how, in this respect, the vegetation of the ancient world corresponds to the vegetation in the present day. I intend to examine in this manner the most important families of the vegetable kingdom; and I hope, by means of this synthetical method, to attain many desirable conclusions regarding the analogy of many yet doubtful natives of the ancient world.

Animal bodies, as dry fibrous muscles, can also be altered in this manner, but whether they can be converted into another substance I do not venture to assert; but the experiment succeeds with insects, as with flies, gnats, (whose more delicate parts, the wings and feelers, are well preserved,) the muscles of crabs, and also with infusory animals. Thus I saw quite distinctly a species of Daphnia (from the half putrid water of a water-barrel) which had been placed in a solution of iron, become converted into iron after being exposed to a red heat for half an hour, and even its feet were thus changed. If, then, we were to place infusory animals, whose skeletons did not consist of silica, in a siliceous solution, and then heat them to a red heat, we might be able to form artificially *Bergmehl*, tripoli, and polishing slate, whose composition has recently been unfolded by the extremely important discovery of Ehrenberg. Evidently here, also, the larger or smaller quantity contained by the animal organs of solid materials insoluble in water (viz. phosphate of lime), would exercise great influence on the success of the experiment. In the parts richly provided with fat, that substance would oppose insuperable obstacles to the preservation of the form, for during the heating it would swell out, and change the whole into a formless mass. I intend to prosecute also these experiments; and, in the mean time, we may, perhaps, regard the last-mentioned circumstance as the reason that animals of a higher class cannot be petrified.

The experiments now communicated seem to me to throw an important light on the process of petrifaction. We may assert, with safety, that the first act began with impregnation, and that then the organic matter was removed either by a high temperature, or by the moist method, or by a gradual

decay. The last seems to me by much the most probable, and hence also the greater compactness of fossil wood may be explained, a topic which, owing to the extensive range of the whole subject, and the short time devoted to it, I did not reach. Although nature certainly did not employ the acids which I used, in her formation of the woods converted into flint or calcedony, yet the possibility of imitation has here been proved, and we may hope that yet further elucidation of the subject may be attained by other means. But, before succeeding, I will not speak of the attempts which I have already commenced to reach the desired object. In conclusion, I have to remark, that specimens have been sent of the imitations of organic remains to the collections of Berlin and Breslau.—*Poggendorf's Annalen.*

FIRE BALLS.

It is a fact that has been long known, that clays, and several other incombustible substances when mixed with sea coal in certain proportions, cause the coal to give out more heat in its combustion, than it can be made to produce when it is burned pure and unmixed; but the cause of this increase of heat does not appear to have been yet investigated with that attention which so extraordinary and important a circumstance seems to demand.

Daily experience teaches us that all bodies, those which are incombustible as well as those which are combustible and actually burning, throw off in all directions heat, or rather calorific (heat making) rays which generate heat wherever they are stopped, or absorbed; but common observation was hardly sufficient to show any perceptible difference between the quantities of calorific rays thrown off by different bodies when heated to the same temperature, or exposed in the same fire; although the quantities so thrown off might be, and probably are, very different.

It has lately been ascertained, that when the sides and back of an open chimney fire-place in which coals are burned are composed of fire-bricks, and heated red hot, they throw off into the room incomparably more heat than all the coals that could possibly be put into the grate, even supposing them to burn with the greatest possible degree of brightness. Hence it appears that a red-hot burning coal does not send off near so many calorific rays, as a piece of red-hot brick or stone of the same form and dimensions; and this interesting discovery will enable us to make some very important improvements in the construction of our fire-places, and also in the management of our fires.

The fuel instead of being employed to heat the room directly, or by the direct rays from the fire, should be so disposed, or placed, as to heat the back and sides of the grate; which must be always constructed of fire-brick, or fire-stone, and never of iron, or of any other metal. Few coals, therefore, when properly placed, make a much better fire than a larger quantity; and shallow grates, when they are constructed of proper materials, throw more heat into a room, and with a much less consumption of fuel, than deep grates; for a large mass of coals in the grate arrests the rays which proceed from the back and sides of the grate from ever being sufficiently heated to assist much in heating the room, even though they be constructed of good materials, and large quantities of coal be consumed in them.

It is possible, however, by a simple contrivance, to make a good and economical fire in almost any grate, though it would always be advisable to construct fire-places on good principles, or to improve them by judicious alterations, rather than to depend on the use of additional inventions for correcting their defects.

To make a good fire in a bad grate, the bottom of the grate must first be covered with a single layer of balls, each ball being 2½ or 2¾ inches in diameter. On this layer of balls the fire is to be kindled, and, in filling the grate, more balls are to be added with the coals that are laid on; care must, however, be taken in this operation to mix the coals with the balls well together, otherwise, if a number of the balls should get together in a heap, they will cool, not being kept red-hot by the combustion of the surrounding fuel, and the fire will appear dull in that part; but if no more than a due proportion of the balls are used, and if they are properly mixed with the coals, they will all, except it be those perhaps at the bottom of the grate, become red-hot, and the fire will not only be very beautiful, but it will send off a vast quantity of radiant heat into the room, and will continue to give out heat for a great length of time. It is the opinion of several persons who have for a considerable time practised this method of making their fires, that more than one-third of the fuel usually consumed may be saved by this simple contrivance. It is very probable that, with careful and judicious management, the saving would amount to one-half, or fifty per cent.

As these balls, made in moulds and burnt in a kiln, would last a long time, probably several years, the saving of expense in heating rooms by chimney fires with bad grates, in this way, is obvious; but still, it should be remembered that a saving quite as great may be made by altering the grate, and making it a good fire-place.

In using these balls, care must be taken to prevent their accumulating at the bottom of the grate; as the coals go on to consume, the balls mixed with them will naturally settle down towards the bottom of the grate, and the tongs must be used occasionally to lift them up. And as the fire grows low, it will be proper to remove a part of them, and not to replace them in the grate till more coals are introduced: a little experience will show how a fire made in this manner can be managed to the greatest advantage, and with the least trouble.

Balls made of pieces of any kind of well burnt hard brick, though not equally durable with fire-brick, will answer very well, provided they are made perfectly round; but if they are not quite globular their flat sides will get together, and by obstructing the free passage of the air amongst them, and amongst the coals, will prevent the fire from burning clear and bright.

The best composition for making these balls, when they are formed in moulds, and afterwards dried and burnt in a kiln, is pounded crucibles, mixed up with moistened Stourbridge clay; but good balls may be made with any very hard burnt common bricks, reduced to a coarse powder and mixed with Stourbridge clay, or even with common clay. The balls should always be made so large as not to pass through between the front bars of a grate.

These balls have one advantage which is peculiar to them, and which might perhaps recommend the use of them to the curious, even in fire-places constructed on the best principles; they cause cinders to be consumed almost entirely,—and even the very ashes may be burnt, or made to disappear, if care

be taken to throw them repeatedly upon the fire when it burns with intense heat. It is not difficult to account for this effect in a satisfactory manner; and in accounting we shall explain a circumstance on which it is probable that the great increase of the heat of an open fire, where these balls are used, may in some measure depend. The small particles of cinder which, in a common fire, fall through the bottom of the grate, and escape combustion, when these balls are used, can hardly fail to fall and lodge on some of them; and as they are intensely hot, these small bodies which alight upon them in their fall, are soon heated red-hot, and disposed to take fire and burn; and, as fresh air from below the grate is continually making its way upwards amongst the balls, every circumstance is highly favorable to the rapid and complete combustion of these small inflammable bodies. But if these small pieces of coal and cinder should in their fall, happen to alight on the metallic bars which form the bottom of the grate, (as these bars are conductors of heat, and, on account of that circumstance, as well as of their situation below the fire, they never can be made very hot,) any small particles of fuel that happens to come in contact with them, not only cannot take fire, but would cease to burn, should it arrive in a state of actual combustion.

THE PINNA AND ITS SILK.

The pinna belongs, like the common edible muscle, to the order of the *vermes testacea*. Its shell is bivalve, fragile, and furnished with a beard; the valves hinge without a tooth. The pinna does not fasten itself to rocks in the same situation as the muscle, but sticks its sharp end into the mud or sand, while the rest of the shell remains at liberty to open in the water. In common with the muscle, it has the power of spinning a viscid matter from its body, in the manner of the spider and caterpillar. Although the pinna is vastly larger than the muscle, its shell being often found two feet long, the threads which it produces are much more delicate and slender than those of the muscle, and scarcely inferior in fineness and beauty to the single filament of the comparatively minute silkworm. Threads so delicately thin, as may readily be imagined, do not singly possess much strength; but the little power of each is made up by the aggregate of the almost infinite number which each fish puts forth to secure itself in a fixed situation, and to preserve it against the rolling of the waves. The threads are, however, similar in their nature to those of the muscle, differing only in their superior fineness and greater length. These fish have, therefore, been distinguished by some naturalists, the one as the silkworm, the other as the caterpillar of the sea.

It was always well known that muscles have the power of affixing themselves either to rocks or to the shells of one another, in a very firm manner; yet their method of effecting this was not understood until explained through the accurate observations of M. Reaumur. He was the first naturalist who ascertained that if, by any accident, the animals were torn from their hold, they possessed the power of substituting other threads for those which had been broken or injured. He found that if muscles, detached from each other, were placed in any kind of vessel and then plunged into the sea, they contrived in a very short time to fasten themselves both to the sides of the vessel and to one another's shells: in this process, the extremity of each thread seemed to perform the office of a hand in seizing upon the body to which it would attach itself.

The threads issue from the shell at that part where it naturally opens, and affixing themselves to any substance, form numerous minute cables, by aid of which the fish steadies itself in the water. Each animal is furnished with an organ, which it is difficult to designate by any name, since it performs the office of so many members, and is the only indicator of the existence of vital powers in the creature. It is by turns a tongue, an arm, and sometimes a leg. Its shape resembles that of a tongue, and it is, therefore, most frequently called by that name. Whenever the fish requires to change its place, this member serves to drag its body forward, together with its cumbrous habitation: in performing its journey the extremity of this organ, which may then be called a leg, is fixed to some solid body, and being then contracted in its length, the whole fish is necessarily drawn towards the spot where it has fixed itself; and by a repetition of these movements, the animal arrives at its destination. It is not often that the organ is put to this use, as the pinna is but little addicted to locomotion: some naturalists indeed affirm that it is always stationary. The use to which the tongue is most frequently applied is that of spinning the threads. Although this body is flat, and similar in form to a tongue through the greater part of its length, it becomes cylindrical about the base or root, where it is much smaller than in any other part: at this lower end are several ligatures of a muscular nature, which hold the tongue firmly fixed against the middle of the shell; four of these cords are very apparent, and serve to move the tongue in any direction according to the wants of the fish. Through the entire length of this member there runs a slit, which pierces very deeply into its substance, so as almost to divide it into two longitudinal sections; this slit performs the office of a canal for the liquor of which the threads are formed, and serves to mould them into their proper form: this canal appears externally like a small crack, being almost covered by the flesh from either side, but internally it is much wider, and is surrounded by circular fibres. The channel thus formed extends regularly from the tip to the base of the tongue, where it partakes of the form of the member and becomes cylindric, forming there a close tube or pipe in which the canal terminates. The viscid substance is moulded in this tube into the form of a cord, similar to the threads produced from it, but much thicker, and from this cord all the minute fibres issue and disperse. The internal surface of the tube in which the large cord is formed is furnished with glands for the secretion of the peculiar liquor employed in its production, and which liquor is always in great abundance in this animal as well as in muscles.

Reaumur observed, that although the workmanship, when completed, of the land and sea animals, is the same, the manner of its production is very different. Spiders, caterpillars, and the like, form threads of any required length, by making the viscous liquor of which the filament is formed pass through fine perforations in the organ appointed for this spinning. But the way in which muscles form their thread is very different; as the former resembles the work of the wire-drawer, so does the latter that of the founder who casts metals in a mould. The canal of the organ destined for the muscle's spinning is the mould in which its thread is cast, and gives to it its determinate length.

Reaumur learned the manner of the muscle performing the operation of spinning by actually placing some of these fish under his constant inspection. He kept them in his apartment in a vessel filled with sea water, and distinctly saw them open their shells and put forth the tongue. They extended and contracted this organ several times, obtruding it in every direction, as if seeking the fittest place whereon to fix their threads. After these trials had been often repeated, the tongue of one was observed to remain for some time on the spot chosen, and being then drawn back with great quickness, a thread was very easily discerned, fastened to the place: this operation was repeated, until all the threads were in sufficient number, one fibre being produced at each movement of the tongue.

The old threads were found to differ materially from those newly spun, the latter being whiter, more glossy, and more transparent than the former, and it was thence discovered that it was not the office of the tongue to transfer the old threads one by one to the new spots where they were fixed, which course M. Reaumur had thought was pursued. The old threads once severed from the spot to which they had been originally fixed were seen to be useless, and that every fibre employed by the fish to secure itself in a new position was produced at the time it was required; and, in short, that nature had endowed some fish, as well as many land insects, with the power of spinning threads, as their natural wants and instincts demanded. This fact was established incontrovertibly by cutting away, as close to the body as they could be safely separated, the old threads, which were always replaced by others in as short a space of time as was employed by other muscles not so deprived in fixing themselves.

"The pinna and its cancer friend" have on more than one occasion been made subjects for poetry. There is doubtless some foundation for the fact of the mutual alliance between these aquatic friends which has been thus celebrated; yet some slight coloring may have been borrowed from the regions of fancy to adorn the verse, and even the prose history of their attachment may be exposed to the same objection.

These fish are found on the coasts of Provence and Italy, and in the Indian ocean. The largest and most remarkable species inhabits the Mediterranean sea.

The scuttle-fish, a native of the same seas as the pinna, is its deadly foe, and would quickly destroy it, if it were not for its faithful ally. In common with all the same species, the pinna is without the organs of sight, and could not, therefore, unassisted, be aware of the vicinity of its dangerous enemy. A small animal of the crab kind, itself destitute of a covering, but extremely quick-sighted, takes refuge in the shell of the pinna, whose strong calcareous valves afford a shelter to her guest, while he makes a return for this protection by going forth in search of prey. At these times the pinna opens her valves to afford him egress and ingress: if the watchful scuttle-fish now approach, the crab returns immediately with notice of the danger to her hostess, who, timely warned, shuts her door and keeps out the enemy. When the crab has, unmolested, succeeded in loading itself with provisions, it gives notice by a gentle noise at the opening of the shell, and when admitted, the two friends feast together on the fruit of its industry. It would appear an arduous, nay, almost an impossible task, for the defenceless and diminutive crab, not merely to elude its enemies and return home, but likewise to obtain a supply of provender sufficient to satisfy the wants of its larger companion. The following different account of the nature of this alliance is much more in agreement with probability:—

Whenever the pinna ventures to open its shell, it is immediately exposed to the attacks of various of the smaller kinds of fish, which, finding no resistance to their first assaults, acquire boldness and venture in. The vigilant guard, by a gentle bite, gives notice of this to his companion, who, upon this hint, closes her shell, and having thus shut them in makes a prey of those who had come to prey upon her: when thus supplied with food, she never fails to share her booty with so useful an ally.

We are told that the sagacious observer Dr. Hasselquist, in his voyage about the middle of the last century to Palestine, which he undertook for objects connected with the study of natural history, beheld this curious phenomenon, which, though well known to the ancients, had escaped the attention of the moderns.

It is related by Aristotle that the pinna keeps a guard to watch for her, which grows to her mouth, and serves as her caterer: this he calls pinnophylax, and describes as a little fish with claws like a crab. Pliny observes, that the smallest species of crab is called the pinnotores, and being from its diminutive size liable to injury, has the prudence to conceal itself in the shells of oysters. In another place he describes the pinna as of the genus of shell-fish, with the further particulars that it is found in muddy waters, always erect, and never without a companion, called by some pinnotores, by others pinnophylax; this being sometimes a small squill, sometimes a crab, which remains with the pinna for the sake of food.

The description of the pinna by the Greek poet Oppianus, who flourished in the second century, has been thus given in English verse:—

> "The pinna and the crab together dwell,
> For mutual succour in one common shell;
> They both to gain a livelihood combine,
> That takes the prey, when this has given the sign;
> From hence this crab, above his fellows famed,
> By ancient Greeks was Pinnotores named."

It is said that the pinna fastens itself so strongly to the rocks, that the men who are employed in fishing for it are obliged to use considerable force to break the tuft of threads by which it is secured fifteen, twenty, and sometimes thirty feet below the surface of the sea.

The fishermen at Toulon use an instrument called a cramp for this curious pursuit. This is a kind of fork, whose prongs are each about eight feet in length and six inches apart, and placed at right angles to the handle, the length of which is regulated by the depth of water. The pinnæ are seized, separated from the rock, and raised to the surface by means of this instrument.

The threads of the pinna have from very ancient times been employed in the manufacture of certain fabrics. This material was well known to the ancients, as some suppose, under the name of byssus, and was wrought in very early times into gloves and other articles of dress and ornament. It appears that robes were sometimes made of this produce, since we learn from Procopius that a robe composed of byssus of the pinna was presented to the satraps of Armenia by the Roman emperor.

A writer of the year 1782, evidently refers to the pinnæ marinæ, when he says, "The ancients had

a manufacture of silk, and which, about forty years ago, was revived at Tarento and Regio, in the kingdom of Naples. It consists of a strong brown silk, belonging to some sort of shell, of which they make caps. gloves, stockings, waistcoats, &c., warmer than the woollen stuffs, and brighter than common silk. I have seen such kind of silk in shells myself; I think it was of the pecten kind, but cannot be sure."

Several beautiful manufactures are wrought with these threads at Palermo. They are in many places the chief object of the fishery, and the silk is found to be excellent. The produce of a considerable number of pinnæ is required to make only one pair of stockings. The delicacy of this singular thread is such that a pair of stockings made of it can be easily contained in a snuff-box of ordinary size. Some stockings of this material were presented, in the year 1754, to pope Benedict XIV.; and, notwithstanding their extreme fineness, were found to protect the legs alike from cold and heat. Stockings and gloves of this production, however thin, are too warm for common wear, but are esteemed useful in gouty and rheumatic cases. This great warmth of the byssus, like the similar quality in silk, results probably from both being imperfect conductors of heat as well as of electricity.

It is not probable that this material will ever be obtained in much abundance, or that it will cease to be a rarity, except in the places of its production. It is never seen in England, save in the cabinets of the curious.

The appearance and general characteristics of the produce of the pinna, the spider, and the silkworm, are so similar, as to have acquired for them one generic name. If all their constituent parts be alike, it forms another among the numerous subjects for surprise and admiration, excited by contemplating the wonderful works of nature, that the same silky principle can be alike elaborated from the fish, the fly, and the mulberry leaf.

A GALVANO-ARSENICAL APPARATUS.

At the last meeting of the Royal Institution, Mr. S. T. Martin, of the Royal Veterinary College, exhibited this apparatus. The action depends on a well-known power, viz., that of resolving water into its constituents, and effecting the reduction of the metals.

The vessel and tubes being filled with a suspected fluid, rendered slightly sour by the addition of sulphuric acid (so as to make it a better conductor of electricity), is to be connected with a galvanic battery of a few plates, by means of electrodes dipping into mercury cups, when decomposition will immediately commence, and if any arsenic be present, the metal *arsenicum* will be resolved at the negative electrode in combination with hydrogen, forming arsenuretted hydrogen gas, which rising will displace the water in the tube.

As soon as the tube is full, the stop-cock is to be turned, and the gas inflamed as it issues from the jet, when on holding a piece of porcelain or a watch-glass over the flame, a metallic film will be deposited on it. That this is arsenicum is to be proved by the usual tests.

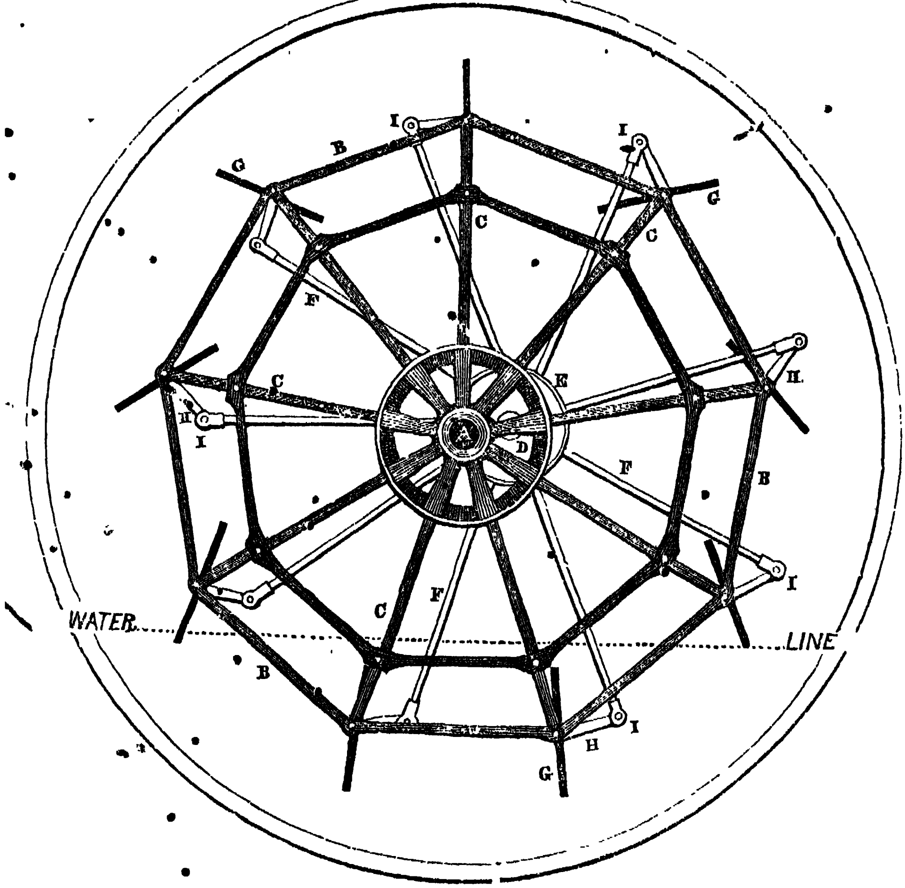
A solution of one grain of arsenious acid in a gallon of water, or of one part in above 76,000, has by it been made to yield many metallic films, and it is possible that the division might have been carried much farther, and yet indications of the existence of the poisonous agent obtained.

MISCELLANIES.

New Economical Lamp.—The *Fanal*, Brussels paper, mentions a lamp which has been recently invented by M. Pélabon, which gives as much light as three candles, may be very easily used, and burns only a centilitre of oil an hour. This lamp consists of a cylinder of copper or tin, in which a piston slides, which is lifted up every five hours, and in descending raises the oil to the burner. It is acted on by a spring, to which M. Pélabon has found the means of giving an equal force at all points of its action. This is effected by compensation, the oil being made to drop on the piston, and so increase by its weight the downward force, as to produce an equivalent to what is lost by the spring in unbending. The cost of this lamp is stated to be about thirty francs. The *Fanal* says the burner is extremely small, but the light it affords is equal to that of three candles.

Percussion Shell to Explode at the Bottom of the Sea.—At a recent meeting of the Royal Society, the following description of a shell to explode under water, invented by Captain J. Norton, was communicated:—An iron tube, like the barrel of a musket, is screwed into a shell of any size, water-tight. A rod of iron, about half a pound in weight, and a foot in length, is suspended within the tube, by means of a split quill passing through a hole in the upper end of the rod, the other end being armed with a percussion-cap. The mouth of the tube is closed with a screw lid, also water-tight. Tin or brass wings being attached to the upper end of the tube, will keep it in a vertical position during its descent to the bottom of the sea; and the shock on its striking the bottom will cause the bar of iron within the tube to fall, and produce the percussion and explosion. Should it be found difficult to make the shell water-proof, I am satisfied that percussion powder made from silver will explode by friction or percussion even when *mixed with water.*

Gas Lighting in London.—For lighting London and its suburbs with gas, there are eighteen public gas-works; twelve public gas-work companies; £2,800,000 capital employed in works, pipes, tanks, gas-holders, apparatus; £450,000 yearly revenue derived; 180,000 tons of coals used in the year for making gas; 1,460,000,000 cubic feet of gas made in the year; 134,300 private burners supplied to about 400,000 customers; 30,400 public, or street, consumers; about 2,650 of these are in the city of London; 380 lamplighters employed; 176 gas-holders, several of them are double ones, capable of storing 5,500,000 cubic feet; 890 tons of coals used in the retorts, in the shortest day, in twenty-four hours; 7,120,000 cubic feet of gas used in the longest night, say 24th December; about 2,500 persons employed in the metropolis alone in this branch of manufacture: between 1822 and 1827, the consumption was nearly doubled; and, between 1827 and 1837, it was again nearly doubled.—*Mr. Hedley, Engineer of the Alliance Gas Works, Dublin.*



MORGAN'S PATENT PADDLE WHEEL.

The numerous accidents that have occurred, particularly in the river to small boats, from the swell, or motion of the water, caused by the great number of steam-vessels continually passing over it, must have made any invention even partially to remedy this great evil valuable in the extreme.

As long as paddle-wheels are universally used as a means of propelling vessels, this object cannot be entirely effected; but that it can be remedied to a certain extent will be seen by the following description of Morgan's patent paddle wheel:—

The ordinary paddle is simple enough, consisting merely of two or more wheels of iron, connected together by cross braces, and supporting boards or floats round the rim at equal distances, and radiating from the centre; this being fixed to a strong shaft running through the vessel is turned by the machinery inside; the resistance caused by the revolution of the floats in the water produces the force by which the vessel is moved.

It is evident that in this mode of construction two kinds of power are lost; first, by the action of the paddle being oblique when it enters the water, tending to lift the vessel instead of propelling it forward, and on leaving the water lifting up a quantity of the fluid with it; and, secondly, by the

receding of the wheel in the water, necessary to create a resistance, equal to the force applied by the engine, in the same manner that the wheel of a locomotive engine sometimes slips round on the rail, instead of holding to it, for want of sufficient friction.

It is obvious that if a paddle is so constructed that the floats shall be perpendicular on entering and leaving the water, many of these objects will be obtained; the following wheel answers both these purposes:—B B B is a polygonal frame, of which there are two connected by diagonal braces, C C C being the arms or spokes of the wheel. A is the centre shaft running through the vessel. D is an axle fixed to the paddle-box. F F F are arms firmly fixed to E, which is a plate of iron revolving on the axle D. G are the paddle floats, each with a fixed arm H, connected with the radii F F, at the joints I I.

It will now be readily seen, from the above diagram, how the wheel F F revolving with the paddle-wheel C C, will always keep the floats G G in a perpendicular position.

This is, I believe, the best of the numerous inventions we are at present acquainted with, the advantages being much less motion of the water; an easier passage to the vessel; much of the unpleasant motion now felt being done away with; and a greater speed, about 1 mile in 16, being gained. This form of paddle wheel has been adopted in H.M. steam frigate, "Medea," and in many of the Admiralty steamers.—Your's respectfully,

A. F.

AMALGAMS.

Amalgamation is the combination of mercury with any other metal. The compound has always been called an amalgam, though properly speaking it is an alloy. The general way of combining mercury with metals is by heat. Amalgams of some metals may be made by merely triturating them with mercury in a mortar.

Amalgam of Gold or Silver.—Place a gold leaf in the palm of the hand, and pour upon it a globule of mercury. The latter will be seen to absorb, or combine with the gold, in the same manner as sugar or table salt mixes with water. Persons who have taken mercurial preparations internally, seldom fail to observe the readiness with which the mercury transudes through the pores of the skin, attaching itself to the gold of their watches, rings, sleeve-buttons, or ear-rings, and rendering them of a white color. A piece of gold, of the thickness even of a guinea, being rubbed with quicksilver, is soon penetrated by it, and made so fragile, that it may be broken between the fingers with ease. It is this property which quicksilver has of uniting itself with gold and silver, that has rendered it of such great use to the Spaniards in America. They reduce the earths or stones, containing gold or silver in their metallic states, into a very fine powder; they mix this powder with quicksilver; and the quicksilver, having the quality of uniting itself with every particle of those precious metals, but being incapable of uniting with any particle of earth, extracts the metals from the largest portions of earth. The quicksilver, which has absorbed either gold, or silver, or a mixture of both, is separated from the substance it has absorbed by evaporation; the quicksilver flies off in vapour, and the precious metal remains in the vessel.

Put two drams of mercury into a crucible, and heat it until a vapour be seen to arise from it; now throw into the crucible 1 dram of gold or silver, and stir them with an iron rod. When the gold or silver is known to be fused, the amalgam is formed, and should be poured into a basin of cold water; when cool, pour off the water, and collect the amalgam, which will be a yellowish silvery mass of about the consistency of soft butter. This, after having been bruised in a mortar, or shaken in a strong phial, with repeated portions of salt and water, (till the water ceases to be fouled by it,) is fit for use, and may be kept for any length of time without injury, in a corked phial. It is of essential importance that the materials of this amalgam, and especially the mercury, should be perfectly pure, as the least portion of bismuth would very materially injure the beauty of the gilding, (when the amalgam is used for this purpose,) deteriorating the color of the gold, and filling it with black specks. On this account, no mercury should be employed but what has been distilled from the oxide of mercury, (red precipitate) either alone, or mixed with a little charcoal powder. When any substance is to be silvered or gilt, it must be first made very clean; (copper, for example) then rubbed over with the amalgam, and then exposed to a heat of 656°; when the mercury will fly off, leaving a coat of silver or gold on the copper. There are furnaces constructed for the volatilization of mercury from gilded vessels, by which the vapour of the mercury is prevented from affecting the hands or face of the operator: before this invention, gilding was a very unwholesome occupation.

Amalgam of Sodium.—Place a globule of sodium weighing 15 grains, in a dry watch-glass, and bring into contact with it 10 grains of mercury. They will instantly combine, forming a solid alloy of beautiful lustre. During this combination, considerable heat will be given out.

Amalgam of Potassium.—Place a globule of the size of a pea, on a piece of writing paper, and bring near to it a globule of potassium of the size of of swan shot; touch the paper so that the two metals may come in contact. The instant this takes place, heat will be given out, and they will incorporate, forming a complete amalgam.

This amalgam, in a few seconds, will become solid, although only a small quantity of a solid metal has been used, with double its size of a fluid one. It is by this consolidation and condensation of their particles that the heat is given out: consequently the specific gravity of the new compound is greater than that of the separate bodies.

Phenomena on the Separation of Potassium from its Amalgam.—Put the above mentioned solid amalgam into a tea-cup, containing warm or cold water:—The potassium will here show its greater affinity for oxygen than for mercury, by quickly leaving the latter (which of course sinks to the bottom), and combining with the former, which it takes from the water. The hydrogen will be set free, and the whole action will be accompanied by considerable noise. Turmeric paper immersed in the tea-cup will show that a solution of potass has been formed. A similar effect will take place, but unaccompanied by considerable noise. Turmeric paper immersed in the tea-cup will show that a solution of potass has been formed. A similar effect will take place, but unaccompanied by noise, when this amalgam is exposed to the action of the air.

Amalgam for the Cushions of Electrical Machinery.—Melt together in a crucible 2 drams of zinc, and 1 of tin; when fused pour them into a cold crucible, containing 5 drams of mercury. The

mercury will combine with those metals, and form an alloy, (or amalgam, as it is called,) fit to be rubbed on the cushions which press the plate or cylinder of an electrical machine. Before the amalgam is applied, it is proper to rub the cushion with a mixture of tallow and bee's-wax.

Amalgam for Varnishing Figures.—Fuse ½ an ounce of tin, with the same quantity of bismuth, in a crucible; when melted, add ½ an ounce of mercury. When perfectly combined, take the mixture from the fire and cool it. This substance, mixed with the white of an egg, forms a very beautiful varnish for plaster figures, &c.

Amalgam for Silvering Glass Globes, &c.—For this purpose, 1 part of mercury and 4 of tin have been used; but if 2 parts of mercury, 1 of tin, 1 of lead, and 1 of bismuth, are melted together, the compound which they form, will answer the purpose better: either of them must be made in an iron ladle, over a clear fire, and must be frequently stirred. The glass to be silvered must be very dry and clean. The alloy is poured in at the top, and shaken until the whole internal surface is covered.

Amalgams, which Fuse when rubbed together.—Melt 2 drams of bismuth and 2 drams of lead in separate crucibles; pour them into separate vessels, containing a dram of mercury in each; when cold, these alloys will be in a solid state, but if they are rubbed against each other, they will instantly enter into fusion.

AFFECTION AND VAST NUMBER OF FISHES.

It may be supposed that little natural affection exists in this cold-blooded race, and, in fact, fishes constantly devour their own eggs, and, at a later period, their own young, without compunction or discrimination. Some few species bear their eggs about them until hatched; thus, the *syngnathi*, (sea-horse, Pegasus, &c.,) have, beneath the base of the tail, a small cavity, closed by two scaly pieces, which lap over it like folding doors. Within these are placed the eggs, enveloped in a fine membrane, and are allowed to remain there until the young ones appear. This is thought about the utmost extent of care which fishes lavished on their young; but Dr. Hancock has stepped in to rescue at least one species from the unmerited charge.

"It is asserted," he says, "by naturalists, that no fishes are known to take any care of their offspring. Both the species of *hassar* mentioned below, however, make a regular nest, in which they lay their eggs in a flattened cluster, and cover them over most carefully. Their care does not end here; they remain by the side of the nest till the spawn is hatched, with as much solicitude as a hen guards her eggs, both the male and female hassar, for they are monogamous, steadily watching the spawn, and courageously attacking the assailant. Hence the negroes frequently take them by putting their hands into the water close to the nest, on agitating which, the male hassar springs furiously at them, and is thus captured. The *roundhead* forms its nest of grass, the *flathead* of leaves. Both at certain seasons burrow in the bank. They lay their eggs only in wet weather. I have been surprised to observe the sudden appearance of numerous nests in a morning after rain occurs, the spot being indicated by a bunch of froth which appears on the surface of the water over the nest. Below this are the eggs, placed on a bunch of fallen leaves or grass, which they cut and collect together. By what means this is effected seems rather mysterious, as the species are destitute of cutting teeth. It may possibly be by the use of their arms, which form the first ray of the pectoral fins."

Pennant, indeed, gives an additional instance of parental affection in this much-wronged class, for he says, that the blue shark will permit its young brood, when in danger, to swim down its mouth, and take shelter in its belly. The fact he tells us, has been confirmed by the observation of several ichthyologists, and, for his part, he can see nothing more incredible in it than the young of the opossum should seek an asylum to the ventral pouch of its parent. He does not tell us, however, that any of these ichthyologists, who may have seen the young sharks swimming down the throat of their affectionate parent, ever saw one of them *returning*; and until that is seen, we must think the evidence rather incomplete, more particularly as the position and direction of a shark's teeth seem to us to render such a feat next to impossible.

But affection is scarcely to be looked for where the offspring is so very numerous as to put all attempts at even recognising them out of the question. How could the fondest mother love 100,000 little ones at once? Yet this number is far exceeded by some of the matrons of the deep. Petit found 300,000 eggs in a single carp; Leuwenhoeck, 9,000,000 in a single cod; Mr. Harmer found in a mackerel, 500,000; and in a flounder, 1,357,000. M. Rousseau disburthened a pike of 160,000 and a sturgeon of 1,567,000; while from one of this latter class, some other person (whose name we do not immediately recollect), got 119 lbs. weight of eggs, which, at the rate of seven to a grain, would give a total amount of 7,653,200! If all these came to maturity, the world would be, in a short time, nothing but fish; means, however, amply sufficient to keep down this unwelcome superabundance, have been provided. Fish themselves, men, birds, other marine animals, to say nothing of the dispersions produced by storms and currents, the destruction consequent on their being thrown on the beach and left there to dry up, all combine to diminish this excessive supply over demand. Yet, on the other hand (so wonderfully are all the contrivances of nature harmonized and balanced), one of these apparent modes of destruction becomes an actual means of extending the species. The eggs of the pike, the barbel, and many other fish, says M. Virey, are rendered indigestible by an acrid oil which they contain, and in consequence of which they are passed in the same condition as they were swallowed, the result of which is, that being taken in by ducks, grebes, or other water fowl, they are thus transported to situations, such as inland lakes, which, otherwise they could never have attained to, that several lakes in the Alps, formed by the thawing of the glaciers, are now abundantly stocked with excellent fish.

CHEMICAL TESTS.

(*Resumed from page 384, and concluded.*)

To detect Manganese in Minerals.—Exposed to the flame of the blow-pipe, with borax, a purple glass is produced. Manganese may also be known by putting a little muriatic acid to a small quantity

of the powder, and by holding a piece of colored cotton, &c. over the fumes; the color will be destroyed: also by immersing a piece of colored cotton, which will be bleached by the solution.

Manganese has many varieties, and is distributed in great abundance. It may be known by its earthy appearance, and is commonly called *black wad*: this mineral contains fibres imbedded in it, of a metallic lustre. Other varieties are composed of acicular fibres, sometimes aggregated, and have an iron-like splendour. It is very frequent in Devonshire, and when examined, may easily be distinguished from iron, or any other substance.

Tests for Iron Ores.—Iron may be detected by placing a small particle of iron ore under the flame of the blow-pipe; it will not melt, but after it has been kept red-hot a few seconds, the magnet attracts it. Or reduce the particles to powder, put them into a watch-glass, and add a drop or two of sulphuric acid, hold the glass over the flame of a lamp. When perfectly dissolved, throw the whole into a glass of water, to which add a few drops of tincture of galls. The product will be ink. If prussiate of potass be added to another portion, prussiate of iron (Prussian blue) will be precipitated. This will be distinguished by its blue color.

The common iron ore of England, is what is called clay iron stone. It is always found near coal, which is so necessary for its reduction to the metallic state.

Coagulation of Olive Oil, a test for its purity.—This phenomenon takes place, when a small quantity of the solution of acid per-nitrate of mercury is added to a quantity of pure olive oil, and shaken with it. The per-nitrate is prepared by dissolving without heat, six parts by weight of mercury in seven parts and a half of nitric acid, at 1.35 spec. grav. The same solution remains fluid, the excess of acid preventing its crystallization.

When eight parts of this solution are mixed with 29 of pure olive oil, and shaken from time to time; after some hours, the whole congeals into a yellowish mass, and the next day it becomes solid like butter.

This singular property of the per-nitrate, renders it an excellent test of the adulteration of olive oil, by rape, poppy, and other seed oils; as the impure mixture will not become concrete, but will congeal according to the quantity of olive oil in it. Another circumstance adds to the excellence of this test: namely, an *orange hue* which it imparts to the seed oils, also a resinous precipitate which is thrown down from them by it. On the contrary, the Provence olive oil is rendered only very slightly yellow like fresh butter, whilst the Calabrian is perfectly white like tallow.

Tests to distinguish Glass of Antimony from Glass of Lead.—Glass of lead is often imposed on the ignorant for glass of antimony. To detect this fraud, it is necessary to observe the following mode of distinction:—

Glass of antimony has a rich brown or reddish color, with the usual transparency of colored glass. The glass of lead is of a deeper and duller color, against the light is much less transparent, and even, in some instances, it is quite opaque. The specific gravity of the true, never exceeds 4,95; that of the spurious is 6,95, or in round numbers, their comparative weights are as five to seven. Let twenty grains be rubbed fine in a glass mortar, adding half an ounce of muriatic acid; the true dissolves with an hepatic smell the solution is turbid, but has no sediment. The spurious turns the acid yellow, giving out an oxymuriatic odour, and leaves much sediment.

Let a little of each solution be dropped separately into water, the true deposits oxide of antimony in a copious white coagulum, or, if the water has been previously tinged with sulphuret of ammonia, in a fine orange precipitate in water, but in the other liquid, one of dark brown or olive color. A solution of the spurious vinegar has a sweet taste together with the other properties of acetate of lead.

A very small mixture of it may be detected, by its debasing, more or less, the bright orange color of the precipitate, thrown down by sulphuret of ammonia from the solution in any acid. The samples of the spurious, hitherto detected, are of a much thicker and clumsier cast than the genuine, but the appearance is not to be trusted, and no specimen should be allowed to pass without a trial, either of its specific gravity or chemical properties.

To detect Sulphur in Harrowgate Water.—It is well known, that when silver combines with sulphur, or is attacked by sulphuretted hydrogen gas, the compound (sulphuret of silver) is of a black color. It is also well known that Harrowgate and other mineral waters of a similar nature are highly impregnated with sulphuretted hydrogen. Now although the smell of these waters is certainly sufficient to recognise the degree of impregnation, still the best test is silver. Accordingly, throw a shilling into a tumbler of Harrowgate water: in a few seconds, it will be rendered quite black; that is, covered by a coat of black powder.

The sulphur of the mineral water leaves the hydrogen, to combine with the silver: nearly the same effect will take place when a silver spoon is used, in eating an egg.

To detect Adulteration of Tea.—The Chinese sometimes mix the leaves of other shrubs with tea, but this is easily discovered, (if not at first sight,) by making an infusion of it, into which put a grain and a half of blue vitriol or copperas; if it be good genuine green tea, and set in a good light, it will appear of a fine light blue; if it be genuine bohea, it will turn of a blue, next to black; but if they be adulterated, green, yellow, and black colors will be seen in them.

After this fraud was detected, the Chinese dyed the leaves of damaged and ordinary green tea, with Japan earth, (Terra Japonica) which gives the leaf, the infusion, and the tincture, the color of bohea. This is to be discovered many ways: for 1st, a less quantity of this dyed tea, gives a deeper color to the same proportion of water, than if it was good. 2dly, the color it gives the water, will also be of a reddish brown, whereas it should be dark. 3rdly, when the leaves have been washed by standing a little, they will look greener than good bohea. 4thly, this dyed tea is generally much larger; therefore it is a good way also to buy the least leaf bohea. 5thly, the infusion, which should be smooth and balsamic to the palate, tastes rough and more harsh. 6thly, if milk is poured into it, it will rise reddish instead of a dark or blackish brown. 7thly, a little sulphate of iron put into this liquor, will turn it light blue, which ought to be of a deep blue, inclining to black. And 8thly, water of ammonia makes the good tea of a brownish yellow after it has stood a while, like new-drawn tincture of saffron; but it has not that effect in bad tea.

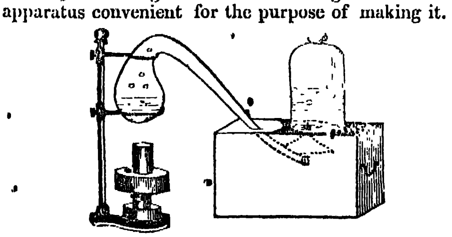
Green Tea is also counterfeited, by dying bad bohea with green vitriol. But this is also easily

discovered : For, 1st, if a bit of gall is put into the infusion, it will turn it of a deep black color ; which it would not do, where there no sulphate of iron in it, for galls do not tincture tea naturally. 2dly, if the liquor is of a pale green, and inclines to a bluish dye, it is bad. 3dly, spirits of hartshorn will make it of a purple color, and cause a slight precipitation, instead of a deep greenish yellow, when it has stood for about six minutes.

NITROUS OXYDE, OR LAUGHING GAS.

Anxious to render every subject as complete as possible, and to make it popular as well as scientific, we add the following remarks and experiments on nitrous oxyde, as a continuation to the article in page 334, on that subject.

Place in a retort some crystals of the nitrate of ammonia; distil these with a heat gentle at first, afterwards increasing it gradually to about 400 degrees ; at a greater heat than this the retort would burst. A fume or vapour will first appear to fill the retort ; when this is the case, and the common air seems to be driven out, immerse the beak of the retort under a receiver, or to the foot of a gasometer, and the laughing gas will pass over. It should be collected over *warm* water, and before it is inhaled it should be suffered to remain in contact with water some hours, in order that it may become purified from any taint of nitrous gas that may be mixed with it. The following cut shows the arrangement of the apparatus convenient for the purpose of making it.



Ex.—Burning Taper.—Prepare a jar of nitrous oxide gas, and immerse in it a lighted taper ; the flame will instantly be rendered more vivid, and as the taper burns slight detonations will be heard.

When the gas has been nearly expended, the external film or flame will be of a very beautiful azure hue ; at first it will be yellow.

Ex.—Burning of Charcoal.—If a piece of red-hot charcoal be introduced into a jar of nitrous oxide gas, it will burn with almost the same brilliancy that it does in oxygen gas.

Ex.—Burning of Iron Wire.—Attach a small piece of phosphorus to a spiral wire, similar to that used for combustion in oxygen gas ; set fire to the phosphorus, and when in a state of inflammation, introduce it into a large jar of nitrous oxide gas: a very beautiful scintillating combustion, with much splendour, will take place.

Ex.—Burning of Phosphorus.—Immerse a piece of ignited phosphorus in a jar of nitrous oxide gas ; it will burn remarkably quick, and with astonishing splendour.

If a small piece, of double the size of a pin's head, be put in a platinum spoon immersed in the gas, and a thick iron-wire heated to whiteness, be brought in contact with it, an explosion will be the consequence.

Ex.—Combustion of Sulphur.—Dip a long slip of wood in melted sulphur, so that one-half, upwards, may be covered. Light it, and whilst burning with a weak bluish flame, introduce it into a jar of nitrous oxide gas : the flame will be instantly extinguished. Withdraw the match, inflame it again, and [illegible] burn for two or three seconds until the [illegible] then immerse it once more. Instead [illegible] the flame will now be kept up with great splendour. It will be of a delicate red colour.

THE VORTICES OF DESCARTES.

The vortices of Descartes though long justly exploded, yet being the fiction of a very superior mind, they are still an object of curiosity, as being the foundation of a great philosophical romance. According to the author of that romance, the whole of infinite space was full of matter ; for with him matter and extension were the same, and, consequently, there could be no void. This immensity of matter he supposed to be divided into an infinite number of very small cubes, all of which being whirled about upon their own centres, necessarily gave occasion to the production of two different elements. The first consisted of those angular parts which, having been necessarily rubbed off and ground yet smaller by their mutual friction, constituted the most subtile and moveable part of the matter. The second consisted of those little globules that were formed by the rubbing off of the first. The interstices betwixt these globules of the second element were filled up by the particles of the first. But in the infinite collisions which must occur in an infinite space filled with matter, and all in motion, it must necessarily happen that many of the globules of the second element should be broken and ground down into the first. The quantity of the first element having thus been increased beyond what was sufficient to fill up the interstices of the second, it must, in many places have been heaped up together, without any mixture of the second along with it. Such, according to Descartes, was the original division of matter. Upon this infinitude of matter thus divided, a certain quantity of motion was originally impressed by the Creator of all things, and the laws of motion were so adjusted as always to preserve the same quantity in it, without increase and without diminution. Whatever motion was lost by one part of matter, was communicated to some other ; and whatever was acquired by one part of matter was derived from some other: and thus, through an eternal revolution from rest to motion, and from motion to rest, in every part of the universe, the quantity of motion in the whole was always the same. But as there was no void, no one part of matter could be moved without thrusting some other out of its place, nor that without thrusting some other, and so on. To avoid an infinite progress, he supposed that the matter which any body pushed before it, rolled immediately backwards to supply the place of that matter which flowed in behind it; as we may observe in the swimming of a fish, that the water which it pushes before it immediately rolls backward to supply the place of what flows in behind it, and thus forms a small circle or vortex round the body of the fish. It was in the same manner that the motion originally impressed by the Creator upon the infinitude of matter necessarily produced in it an infinity of greater and smaller vortices, or circular streams; and the law of motion being so adjusted as always to preserve the same quantity of motion in the universe, vortices either continued

for ever, or, by their dissolution, gave birth to others of the same kind. There was thus, at all times, an infinite number of greater and smaller vortices, or circular streams, revolving in the universe.

But whatever moves in a circle is constantly endeavouring to fly off from the centre of its revolution. For the natural motion of all bodies is in a straight line. All the particles of matter in each of those greater vortices, were continually pressing from the centre to the circumference, with more or less force, according to the different degrees of their bulk and solidity. The larger and more solid globules of the second element forced themselves upwards to the circumference, while the smaller, more yielding, and more active particles of the first, which could flow even through the interstices of the second, were forced downwards to the centre. They were forced downwards to the centre notwithstanding their natural tendency was upwards to the circumference; for the same reason that a piece of wood, when plunged in water, is forced upwards to the surface, notwithstanding its natural tendency is downwards to the bottom; because its tendency downwards is less strong than that of the particles of water, which, if one may say so, press in before it, and thus force it upwards. But there being a greater quantity of the first element than what was necessary to fill up the interstices of the second, it was necessarily accumulated in the centre of each of these circular streams, and formed there the fiery and active substance of the sun. For, according to that philosopher, the solar systems were infinite in number, each fixed star being the centre of one; and he is among the first of the moderns who thus took away the boundaries of the universe. Even Copernicus and Kepler themselves have confined it within what they supposed the vault of the firmament.

The centre of each vortex being thus occupied by the most active and moveable parts of matter, there was necessarily among them a more violent agitation than in any other part of the vortex, and this violent agitation of the centre cherished and supported the movement of the whole. But among the particles of the first element, which fill up the interstices of the second, there are many, which, from the pressure of the globules on all sides of them, necessarily receive an angular form, and thus constitute a third element of particles, less fit for motion than those of the other two. As the particles, however, of this third element were formed in the interstices of the second, they are necessarily smaller than those of the second, and are along with those of the first, urged down towards the centre, where, when a number of them happen to take hold of one another, they form such spots upon the surface of the accumulated particles of the first element, as are often discovered by telescopes upon the face of that sun which enlightens and animates our particular system. Those spots are often broken and dispelled by the violent agitation of the particles of the first element, as has hitherto happily been the case with those which have been formed upon the face of our sun. Sometimes, however, they incrust the whole surface of that fire which is accumulated in the centre; and the communication betwixt the most active and the most inert parts of the vortex being thus interrupted, the rapidity of its motion immediately begins to languish, and can no longer defend it from being swallowed up and carried away by the superior violence of some other like circular stream; and in this manner, what was once a sun becomes a planet. Thus the time was, according to this system, when the moon was a body of the same kind with the sun, the fiery centre of a circular stream of ether, which flowed continually round her; but her face having been crusted over by a congeries of angular particles, the motion of this circular stream began to languish, and could no longer defend itself from being absorbed by the more violent vortex of the earth, which was then, too, a sun, and which chanced to be placed in its neighbourhood. The moon, therefore, became a planet, and revolved round the earth. In process of time, the same fortune which had thus befallen the moon, befel also the earth; its surface was incrusted by a gross and inactive substance; the motion of its vortex began to languish, and it was absorbed by the greater vortex of the sun. But though the vortex of the earth had thus become languid, it still had force enough to occasion both the diurnal revolution of the earth, and the monthly motion of the moon. For a small circular stream may easily be conceived as flowing round the body of the earth, at the same time that it is carried along by that great ocean of ether which is continually revolving round the sun, in the same manner as, in a great whirlpool of water, one may often see several small whirlpools, which revolve round centres of their own, and at the same time are carried round the centre of the great one.

Such was the cause of the original formation and consequent motions of the planetary system. When a solid body is turned round its centre, those parts of it which are nearest, and those which are remotest from the centre, complete their revolutions in one and the same time. But it is otherwise with the revolution of a fluid; the parts of it which are nearest the centre complete their revolutions in a shorter time than those which are remoter. The planets, all floating in that immense tide of ether which is continually setting in from west to east round the body of the sun, complete their revolutions in a longer or shorter time, according to their nearness or distance from him.

This bold system was eminently fitted to captivate the imagination, and though fraught with contradictions and impossibilities, attempts have been made to revive it, even in this country, under different names. All those systems which represent the motions of the heavenly bodies as being the effect of the physical agency of ethers, of air, of fire, and of light, of which the universe is conceived to be full, labour under the same difficulties with the Cartesian hypothesis; and very few, if any, are so neatly put together. It is surely sufficient, however, to demolish this goodly fabric, barely to ask how an absolute infinity of matter can be divided into cubes, or any thing else? how there can possibly be interstices in a full plenum? or how, in such a plenum, any portion of matter can be thrust from its place?

ANSWERS TO QUERIES,

IN VOL I.—(*See page* 8.)

150.—*How are animal skeletons prepared and bleached?* Answered in page 157.

161.—*How are work boxes, &c. japanned?* Answered in page 103.

167.—*How are Turkey-maw balloons prepared?* Answered in page 104.

175.—*What is there in the juice of the lemon, &c., which used as a sympathetic ink, causes it to appear dark, when scorched by fire?* Milk, the juice of

lemons, onions, &c., become brown, when applied to the fire, simply, because the parts affected by it, are more easily scorched by the heat than the other parts of the paper.—A CORRESPONDENT.

(IN THE PRESENT VOLUME.)

185.—*What is harness polish and its preparation?* Answered on page 63.

186.—*How is printing in gold performed, also the materials for printing inks?* Answered on pages 104 and 184.

189.—*How are insects in cabinets best preserved?* Insects in cabinets are subject to two casualties; one is the fading of the colors of many of them by the action of light; the remedy for this is evident. The other source of injury, and to which the query evidently points is, their destruction, owing to the attack of smaller insects—for this many things have been suggested. The imbueing of them with corrosive sublimate, is one which is perfectly efficacious; but as this is tedious, and with delicate insects not advisable, it is usual to place pieces of camphor in the drawers, which prevents the approach and production of those insects which would be injurious.

192.—*What causes the different colors in the flame of a candle?* Answered on page 84.

193.—*How and of what materials are Meershaum pipes made?* Meershaum is a particular kind of clay, which is found principally in Turkey and Asia Minor. The pipes are made much in the same manner as common tobacco pipes. Vast numbers of pipe bowls are imported from Turkey into Germany, where they are fitted up either for the use of the Germans themselves, or for exportation.

194.—*How are common cake water colors made?* Answered on page 214.

197.—*How are metallic pencils made?* Answered on page 146. Article Bismuth.

199.—*How are organ barrels pricked?* Answered on page 146.

202.—*Why is it that light passing through a green blind appears red?* It is only in certain circumstances that it does so; for example, after having intently looked at it for some minutes, and then looking at something white—in which case, a red may be apparent, and this because red is the complementary color to green. The intenseness of the gaze fatigues the eye, and as a relief from this, the eye has the power of decomposing the white light, from the white object, and absorbing the red rays, or the complementary color, these united forming white.

203.—*Why do liquids applied to wood, cause it to appear darker than before?* The oil, by filling up the pores of the wood, enables it to absorb the rays of light more than it does when in its natural state, consequently it appears darker.

204.—*What will destroy the peculiar odour of naphtha?* If by naphtha is meant that liquid obtained from coal tar we believe that nothing will render it odourless.

205.—*How is bread to be made without yeast?* Some substitutes for yeast are to be found on pages 240 and 356.

206.—*What is the cause of some distilled spirits presenting a milky appearance when diluted with water, and by what means is this to be prevented?* The only spirits which thus change their color by the addition of water, are such as have oil mixed with them—gin for example, is formed of spirits, (alcohol,) the oil of juniper, and other ingredients. If the oil be in excess; when water is added, the affinity between the spirit and oil is destroyed, the spirit leaving the oil, and uniting itself with the water; the oil, therefore, falls down, and renders the mixture turbid. There is no positive remedy for this, but if the liquid be clarified by the addition of a small portion of alum, this will carry down any excess of oil, and the turbidness is, in a great measure, destroyed. Age will have the same effect, though, perhaps, from a different cause; the length of time in which they have been in juxta-position, has united the oil and spirit in a closer affinity.

208.—*How is sand paper for lighting lucifers made?* This ought, properly, to be a coarse glass paper, which may be made thus:—Brush over the surface of a sheet of paper some melted glue, and while this remains wet, sift upon it some powdered glass, previously sifted of a requisite degree of fineness, when dry it will be fit for use.

209.—*How are plaster casts from life taken?* Suppose it be desired to take a cast from a person's face, we should proceed as follows:—Tie the hair back, by a cloth tied over it and around the face; then grease the face well, particularly the whiskers, eye-brows, and eye-lashes, with hogs' lard or butter. Lay the patient, and *patient* he must be, on a table or the floor, face uppermost, and surround the edge of the cloth with a *wall* of putty, or dough, so that it shall rise upwards all round, as much as possible; then make two hollow long cones of paper, and put them in the nostrils, fastening them with the same dough, and taking care that the whole nostril shall thus be filled up. This being ready, mix up some plaster of Paris in a basin, with *warm* water, and pour it over the face, (the eyes and mouth of course being closed) the wall of putty will prevent a great part of it running off, and although this is not sufficient to retain the whole, yet, by the assistance of a knife, it may be taken up when a little set, and plastered on the nose, and upper part of the face, until a perfect continuous surface of mould of plaster is produced; in a minute or two, the plaster will be sufficiently hardened to be taken off the face, and will form a mould, from which a cast like the original may be taken, by a reverse operation, greasing or soaping well the mould, and then pouring plaster into it. Some persons object to having the whole face done at once, if so, half may be operated upon first, and when this half-mould is hardened, the edge of it is to be trimmed, greased, and put upon the face, while the other half is cast to it. The whole face may also be cast at once, and yet the mould separated in two pieces, thus:—Fasten on the face a fine silk cord, by a piece of wax stuck to the forehead, another to the tip of the nose, a third on the lip, and a fourth on the chin; the plaster being poured over the whole face, and suffered to remain till nearly set, the silk cord is to be pulled away, when the mould will be cut in half, and each half be easy of removal.

212.—*How is jewellers' cement made?* In many ways, according to the articles to be cemented together; a piece of pitch is used for the common black buckles—black sealing-wax holds still stronger. For transparent gems, a piece of gum mastic is dropped into the hole, and the gem sufficiently heated, is dropped into it. For uniting together articles, while in the process of manufacture, it is usual to employ a mixture of wax, rosin, and plaster of Paris; a very gentle heat will melt this cement.

213.—*What is the blocking cement used by the gun engravers made of?* Of pitch, wax, and a very little tallow; rosin makes it harder.

217.—*What is the construction of the fire-cloud, as exhibited at the Polytechnic Institution, London?* Answered on page 384.

REVIEW.

The Excise Officers' Manual, and Improved Practical Guager, 1840. Maxwell, p. 368.

THIS is a work whose title promises little to the general reader, or the man of science; but it is one which is valuable not merely to those in the Excise, but to all who deal in exciseable articles—to the distiller, the brewer, publican, soap manufacturer, grocer, vinegar maker, *cum multis aliis*. Mr. Bateman is the author of too many works to need our introduction of him, and this, like all the others, is full of the most valuable information, and given in the simplest and most comprehensive form; thus, taking up the present work, instead of finding it a dull detail of an exciseman's duties, we find a perfect digest of the laws of the Excise, complete statistics of exciseable articles, and instruction on arithmetic, mensuration, and guaging, so full, and yet so easy of comprehension, that it would put to shame many a larger and more learned treatise.

There are very numerous tables and wood-cuts, (we should think some hundreds,) interspersed throughout the book, which materially add to its value.

To the Editor.

SIR.—In Part 23, page 364, in an article on Waves, quoted, (I presume from the signature,) from a work of Dr. Arnott's, I find the following passage:—"Now no wave rises much more than 10 feet above the ordinary sea-level, which, with the 10 feet that the surface afterwards descends below this, gives 20 feet for the whole height, from the bottom of any water-valley to an adjoining summit." Now I must think very differently. I have several times, nay frequently, witnessed seas of *far greater height*, especially near the Cape of Good Hope, in what is termed a north-wester. In rounding the Cape in one of these furious gales, when running under a close-reefed main top-sail, (often on the cap,) and reefed courses, (the lofty sail being only carried to keep the vessel a-head of the sea,) I have seen the lower sails so completely becalmed, by the huge green mountain then curling on the quarter, as to flap against the mast; while on the vessel's rising up its crest, as it rolled under her, the storm has again burst into the canvas, with a fury that has made me fear that it would blow it out of the bolt ropes; literally, (as seamen term it,) "making every thing crack again."

I never rounded "The Horn," but think that Capt. Fitzroy, in his highly interesting, as well as scientific account of his voyages to the Pacific, mentions the same sort of seas in that latitude of storms. Almost any seaman who has encountered a north-wester in the latitude of the Cape, whether in a man of war, or large East-Indiaman, can testify to the same. I should say that some of these huge mountains of water *cannot be less than 60 feet high.* Twenty feet is allowed in observations on board ship, for the height of the eye above the water. This would leave but a small measure for the height of the wave above the deck of such a vessel in the trough between two waves, if Dr. Arnott's height be the true one.—Your's obediently, G. R.

Crawcombe Rectory.

To the Editor.

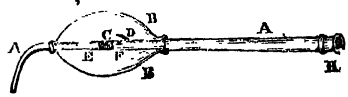
SIR.—I lately immersed a piece of tissue paper in a mixture of linseed oil and sulphuric acid, and it became transparent, and dried in a few moments after taken out of the liquid; if the most transparent tracing paper is the best, this has a far greater degree of transparency than any tracing paper I could procure at the shops. Any object can be seen through it with the same facility as ordinary window glass. A curious property of this paper is, that it possesses transparency enough to be used, (by those who have a taste for drawing, and who wish to indulge their fancy in a variety of subjects, which to buy would become expensive,) as a cheap substitute for glass, in the construction of the slides of the magic and phantasmagoria lanthorn.

When the acid was poured in the oil, it became of a very dark color, and a black substance fell to the bottom of the vessel. If you think proper to notice this in your Magazine it may lead to further improvements. J. B.

IMPROVED BLOW-PIPE.

To the Editor.

SIR.—I herewith send for your inspection a drawing of a blow-pipe, and, by inserting it in your useful work, you will much oblige A CONSTANT READER.



A A is a common brass blow-pipe, which can be purchased at any ironmonger's shop; you must bore two holes in it, F and E, one on each side of C, which is a piece of cork cut the size of the tube, and pushed down tight; D is the leather valve to cover the hole F; B is a bag of India rubber, which must be very thin, and tied at each end on the tube, which can easily be removed, should the valve get out of order. By applying the mouth at H, and blowing down the tube, the cork C will prevent it from going down the tube, and will go through the hole F, and lift the valve D; and the bag will expand and force the air through the hole E in a continued stream.

MISCELLANIES.

Flexible Asphaltic Roofing.—This invention, patented by Mr. Pocock, is intended to supersede the use of slates, tiles, zinc, thatch, &c., in the covering and lining of farm buildings, sheds, cottages, and other erections. It is durable, light and economical: its weight is only 60 pounds to a square of 100 feet, so that the walls and timbers to support it require to be but half the usual substance; it is also a non-conductor of heat, is impervious to damp, and will bear a heat of 220° without injury.

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END OF THE SECOND VOLUME.

ERRATA.

Page 131—for *latinum* and *latinium*, read *latanium*.
,, 136—first column, line 62, for *hydrochlorate*, read *hydrio*
,, 325—second column, line 27, for *cold*, read *hot*.
,, 338—second column, line 10, after *strip*, insert *of copper*.

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